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CERCOSPORA ON THREE POLYGONUM SPECIES GROWING IN PROXIMITY TO BETA VULGARIS L.

by

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Signature was redacted for privacy.

Dean of Graduate College

Iowa State University
Of Science and Technology
Ames, Iowa

1967

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DEDICATION

To the respected memory of my former

Major Professor

the late Dr. Walter F. Buchholtz

Professor of Botany and Plant Pathology

Iowa State University of Science and Technology

Ames, Iowa

under whose very able and learned guidance

a major part of this doctoral dissertation was completed

I. INTRODUCTION

In the spring of 1962, some 2500 acres of sugar beets (Beta vulgaris var saccharita L.) were planted in Monona County in western Iowa. This was the very first attempt to grow the crop in this area. By September there was common occurrence of Cercospora leaf spot, with considerable loss of leaves in several fields.

Such occurrence of leaf spot on the first crop raised the question of possible general source of initial inoculum, specifically, could Cercospora beticola Sacc. possibly be chronically present on some non-crop plants in the area? This possibility seemed especially plausible in light of abundance of weed members of the Chenopodiaceae and Polygonaceae. Fagopyrum sagittatum Gilib., Polygonum species (P. aviculare L., P. coccineum Muhl., P. convolvulus L., P. pennsylvanicum L., and P. persicaria L.), Rumex altissimus Wood, and Rumex crispus L. were especially abundant on waste and non-cropped land and in poorly cultivated fields on the Missouri River flood plain. Common Chenopodiaceae were Chenopodium album L., Kochia scoparia L., and Salsola kali L.

To shed some light on whether any one of these plants might be chronic carriers of C. beticola, the following investigations were undertaken:

1) re-examine the host range of C. beticola, particularly in families Chenopodiaceae and Polygonaceae;

2) determine if plants of these families actually were hosts of C. beticola in locales where sugar beets with leaf spot had been grown;

3) compare Cercospora species on three plants (P. aviculare, P. pennsylvanicum and P. persicaria) in Monona County with Cercospora species on them in Story County (where garden beets have been, and are, the only B. vulgaris grown).

One Polygonum species, P. coccineum, wherever observed and collected, failed to yield evidence of a single Cercospora spot. Some observations were made to check the possibility of a morphological basis for such apparent immunity.

Two observers (Vestal, 43; Canova, 5) have reported instances of entrance of germ tubes of C. beticola through stomata of B. vulgaris. Manipulations and observations were undertaken to probe the possibility of direct penetration of its host by this facultative parasite.

II. LITERATURE REVIEW

The outbreak of Cercospora leaf spot of sugar beets the very first year beets were grown in western Iowa not only presented the problem of source of inoculum, but also related problems as over-wintering of spores, conditions favorable for disease outbreak, culturing of the fungus, and its cultural characteristics on artificial media. A preliminary knowledge of the said factors was essential before proceeding with the purpose for this investigation.

Initial trials performed by previous workers have indicated that the fungus is soil-borne and able to initiate infection from the soil on young beet leaves (1,2,33). Nagel (28) demonstrated viability and growth of the fungus in five different types of soils: namely, peat and four loams—basic black, acid black, neutral black and black with little organic matter. He further demonstrated the fungus to be viable for two and a quarter years when transferred from such soil cultures to ordinary laboratory temperatures.

In 1938 he observed sclerotial-like bodies imbedded in the host tissue that lived throughout the winter and served as overwintering inoculum (30). Singh (40) recorded the presence of similar bodies which he described as chlamydospores in certain species of Cercospora. According to Nagel (30), C. beticola can live in the soil and can spread from the soil to the cotyledons and leaves of the sugar beet plants. At the

end of 18 and 27 months, the organism retained its viability and pathogenicity in sterile soil cultures, while at the end of nine and 20 months, using naturally infested soil, the pathogen retained its virility, but there was marked decline in sporulation.

Nagel (30) cited Vestal's view that spores from certain weed hosts may initiate primary leaf spot infection, while McKay and Pool (24) reported that primary infection was due to over-wintering of the organism on old beet tops. Vestal (43) also suggested that C. beticola not only lived but reproduced saprophytically on dead tissue of the weed hosts and sugar beet.

Coons, Stewart and Kotila (8) have shown the fungus to persist on dried tops for at least three years. High temperatures are necessary for its rapid propagation, which is arrested by cool spring or summer weather. It has also been reported that light brings about an increase in sporulation (4) and that a direct correlation exists between humidity, temperature and disease outbreak (44).

The possibility of seed transmission of C. beticola was pointed by Gassner (16). He found that diseased seeds contained an abundance of conidiophores and conidia. When seed clusters of this type were grown on Chenopodium agar, the fungus developed profusely in the diseased material after six days and continued to increase. Results with treated and

untreated beet seeds grown on Chenopodium agar clearly indicated and confirmed transmission through the seed.

From experiments carried out over a period of two years, Knapp (21) concluded that conidia and sclerotia must be remaining viable on dead plant residues. In vivo studies on C. beticola on beet showed that the fungus may persist on diseased plant debris in the soil during winter, the conidiophores remaining alive and producing conidia as soon as climatic conditions permit. Seed beets also play an important part in the over-wintering of the fungus (23).

The conidia and conidiophores of C. beticola are produced on the leaves, petioles, stems and perianths of B. vulgaris and are the sole over-wintering organs of the pathogen, persisting in the field on decayed plant refuse, remnants of fodder, seed bearer stecklings and seed clusters (13). Canova (5), however, reports perpetuation of C. beticola in unfavorable conditions in the absence of the beet is chiefly by means of mycelium and spores carried on the seed and in leaf detritus on the ground. Over-wintering of the fungus on related weed hosts was only suggested by Vestal (43) and the frequent occurrence of such hosts suggested a part of this investigation.

Innumerable beet selections were studied by Noll (32), Cunningham (9), Townsend (42) and Gabotto (15) and descriptions of diseased areas and the morphology and growth

characteristics of the fungus were recorded. Gilman and Archer (17) carried out experiments which led to the extension of host range of the fungus and Melhus (25) worked with different techniques of inoculation of the fungus.

Solheim (41) found considerable variation in colony color when the same fungus isolate was grown on different media. Working with cultures of Cercospora isolated from clover and alfalfa, Horsfall (18) observed that on artificial media all cultural characteristics were alike. Sporulation was profuse when the fungus was grown in sugar beet agar medium (27) and cultures were kept in sporulating condition for five weeks to three months, when transferred at intervals of four to six days (20). Loss of sporulation was attributed to the development of non-conidial variants that overgrew the original cultures (37).

Ryker (37) further observed that in cultures of certain species of Cercospora, regardless of whether they originate from mycelium from tissues of the host or from single spores, the fungus eventually produces feebly sporulating mycelial variants that over-grow the cultures. Ten strains of C. beticola were isolated from dried beet leaves in Germany, all of which produced typical leaf spot symptoms on plants into which they were inoculated and there was normal spore formation. All evidence indicated lack of physiologic specialization within the species (39). Difference in morphology of the

fungus induced workers to designate forms of the fungus as variants.

Some workers found that isolates of C. beticola tended to produce variants as "islands" of whitish, yellowish, or abundant white aerial growth (12). Evidence was adduced from controlled field experiments in Germany that six monospore cultures of C. beticola differed in pathogenicity to beet and they were designated as races (38).

Fransen (14) observed that conidia were produced as freely in darkness as in light, but maximum sporulation was reported with uniform light source by others (4). Difficulty was encountered in obtaining sporulation of C. beticola in media used normally for other Cercosporas as C. apii (11). However, great success was achieved when using sugar beet agar medium (3,7). High humidity was found to be necessary for growth and sporulation of the fungus (7,35).

In the first report of C. beticola on B. vulgaris in Iowa, other hosts for the fungus reported were Amaranthus retroflexus L., Chenopodium album L., Lactuca sativa L., Malva rotundifolia L., Melilotus alba Desr., and Polygonum convolvulus L. (1). Lieneman (22), in a comprehensive study of the fungus genus Cercospora, lists 516 species, few of which have more than one host. Chupp, in his monograph on the genus Cercospora, cites a large number of species (6). McKay and Pool (24) found that not only sugar beets, but red garden

beets, Swiss chard, mangel wurzel and Martynia louisiana Mill. are susceptible to C. beticola. Nagel (29) extended the host range by adding Polygonum muhlenbergi Meisn., Rumex acetosella L., R. altissimus Wood, R. crispus L., and Spinacea oleracea L. to the list of susceptible plants, but it was Vestal (43) who increased the host range of C. beticola by a wide margin.

The possibility of certain weed hosts serving as sources for primary leaf spot inoculum was suggested by Vestal (43). However, no definite study was carried out to indicate the presence of the fungus on susceptible hosts in non-sugar beet growing areas which might have served as source of inoculum when first outbreaks of Cercospora leaf spot occurred in western Iowa.

With the first outbreak of the disease, the question arose as to whether the fungus penetrated the host through natural openings or whether there was direct penetration through the cuticle. Young (45) observed that penetration hypha of certain fungi usually entered vertical cell walls. A few cases were observed where there was stomatal entrance. Intensive work was done on stomatal movement and germ tube penetration by Pool and McKay (36), which revealed that certain morphological and environmental factors influence stomatal activity and in turn the latter, together with a favorable growth of the fungus, influences infection. Penetration of the leaf by the conidial germ tubes of C. beticola was

observed to occur only through open stomata. They observed that following penetration of the invading organism, the leaf cells appeared to attempt to prevent the further spread of the fungus; but when this was not successful, the fungus by further growth produced a well-defined spot.

Plotho (34) confirmed the entry of the fungus germ tube through stomata, but did not see the necessity of open stomata to be a determining factor. Further studies demonstrated that it was only by chance that a germ tube penetrated a stoma (10). The average number of germ tubes produced by each of 100 conidia ranged from one to seven and frequency of germ tube emission diminished from basal to apical cells (13). Canova (5) stated that infection can occur only through the stomata and takes place readily by means of an infection hypha if they are completely open, but not nearly so easily when the stomata were only half open. The germ tubes are positively hydrotropic and, when stomata are completely open, a very high percentage of infection is obtained.

III. EXPERIMENTS

A. Collection, Culture and Inoculation Procedure

Diseased B. vulgaris leaves were collected from near Onawa in Monona County in western Iowa and portions of the diseased areas were placed in petri plates lined with moist filter paper. After 24 hours, the surface of typical necrotic spots were covered with a glistening layer of upright conidia. Isolation was done by touching such a layer of conidia with a moistened, sterilized needle and then scraping the needle with adhering conidia over the surface of sugar beet decoction agar medium in a test tube. The agar medium thus seeded was allowed to stand for two to three days, after which time there was abundant sporulation. The resulting culture was used for conidial size determinations or host inoculation, transferred or kept in an arrested state in a refrigerator.

The sugar beet decoction agar, a modification of Coon's medium on which Nagel (27) reported maximum sporulation in three days, was prepared by stirring 300 grams of freshly picked macerated young sugar beet leaves into 1000 cc of distilled water in which 12 grams of agar had been dissolved. The mixture was again heated slightly, strained through double cheesecloth and poured into test tubes, which, after plugging with cotton, were autoclaved at 15 pounds pressure for 30 minutes.

On this medium, the fungus formed a characteristic

slow-growing, dense mat of mycelium. The submerged mycelium consisted of short, swollen, olive-green cells, while the aerial mycelium was slow-growing, dark gray at first and later light gray. The conidiophores were olive-green in color and were produced singly or several in a cluster. Conidia were formed in abundance in two days; when they were removed from the culture, a second crop was produced in another 24 to 48 hours.

Plants were inoculated either with conidia from such cultures in suspension in sterile distilled water, or with small portions of cultures which included mycelium and conidiophores as well as conidia. These methods had been reported to be very successful by Noll (31). Inoculum was sprayed or mechanically distributed on the leaf surfaces. Inoculated plants were placed in a moist chamber for 24 hours and kept moist by spraying with water twice during that time. Checks consisted of uninoculated entire plants, half plants or leaves, depending on the availability of plants. After removal from the moist chamber, plants were kept in a greenhouse bench until spots developed, usually about five days.

The same culture and inoculation procedures were followed for all Cercospora species on all hosts.

B. New Hosts for C. Beticola

Among 11 species of Chenopodiaceae and Polygonaceae

commonly observed in Monona County, Chenopodium album L., Rumex crispus L. (Nagel, 27; Vestal, 43), Polygonum convolvulus L., Polygonum pennsylvanicum L., and Rumex altissimus L. (Vestal, 43) had been reported to be experimental hosts of C. beticola. The first approach to probing a general source of inoculum was to find out how many of the 11 species, all taxonomically related to B. vulgaris, could be hosts for C. beticola. Flora of the Missouri River flood plains (26) proved helpful in selection of plants.

Plants of C. album, F. sagittatum, K. scoparia, P. aviculare, P. coccineum, P. pennsylvanicum, P. persicaria, R. altissimus, R. crispus, and S. kali were collected from the field and set in pots in the greenhouse. Seeds of all these and of P. convolvulus were also collected and seedlings of all 11 species were grown in the greenhouse.

Plants were inoculated with three or four day old cultures by methods described previously. Results are summarized in Table 1.

Of the ten weeds determined to be experimental hosts of C. beticola, three were found commonly and in abundance in Monona County, namely P. aviculare, P. pennsylvanicum and P. persicaria. P. coccineum was most abundant of all, but was found not to be an experimental host of C. beticola nor was any Cercospora species found on it in the field. On the other hand, each of the other three Polygonum species was found to

Table 1. Successful inoculations with C. beticola on 10 of 11 common western Iowa weeds of families Chenopodiaceae and Polygonaceae

	Weed species	Number of plants Inoculated — Infected		
		Trial 1	Trial 2	Trial 3
1.	Chenopodium album L.[a,b]	2 - 2	2 - 2	2 - 2
2.	Kochia scoparia L.	3 - 3	2 - 2	3 - 3
3.	Salsola kali L.	3 - 3	3 - 3	2 - 2
4.	Fagopyrum sagittatum Gilib.	2 - 2	2 - 2	2 - 2
5.	Polygonum aviculare L.	4 - 4	2 - 2	4 - 4
6.	Polygonum coccineum Muhl.	2 - 0	1 - 0	1 - 0
7.	Polygonum convolvulus L.[b]	1 - 1	1 - 1	2 - 2
8.	Polygonum pennsylvanicum L.[b]	2 - 2	1 - 1	2 - 2
9.	Polygonum persicaria L.	3 - 3	1 - 1	1 - 1
10.	Rumex altissimus Wood[a,b]	1 - 1	1 - 1	1 - 1
11.	Rumex crispus L.[a]	1 - 1	1 - 1	1 - 1

[a]Successful inoculations reported by Nagel (27).

[b]Successful inoculations reported by Vestal (43).

carry typical Cercospora spots from which were isolated the respective Cercospora species known to parasitize them: Cercospora avicularis Winter from P. aviculare; Cercospora persicariae Yamamoto from P. persicaria; and Cercospora polygonorum Cooke from P. pennsylvanicum. Identification of Cercospora species was done from Chupp (6) and verified (19). Each of these three Polygonum species occurs in Story County and these also were found to carry spots incited by the same respective species of Cercospora.

Therefore, several questions were suggested:

1) Did C. beticola occur on these three common weeds in Monona County?

2) Could any of the three Cercospora species normally occurring on these three hosts be found there on sugar beets?

3) Was C. beticola, when experimentally applied to the three Polygonum species, the same as when occurring on sugar beets; and likewise, were the three respective Cercospora species of the three Polygonum hosts the same on sugar beets as when on their own hosts?

Despite a rather extreme range in length of conidia, it was evident that means of lengths of 50 conidia for isolates of one Cercospora species were surprisingly uniform. Since the three Cercospora species (C. avicularis, C. polygonorum and C. persicariae) on the three Polygonum hosts all formed conidia somewhat shorter than C. beticola, it appeared that mean conidial length might provide reliable characterization

of C. beticola as against any of the other three species. No other readily distinguishing character was evident.

Mean length of 50 conidia was determined from measurements made with the aid of a micrometer eye piece built into a 10X ocular and calibrated with a micrometer stage scale, used in combination with 43X objective of a Bausch and Lomb microscope. Original conidial measurements were obtained by observing the number of divisions of the micrometer eye piece each conidium covered and converting this in terms of microns from the calibration. Original measurements are reported in the Appendix. The conidia were taken from a fresh agar culture and mounted in water containing a small amount of a detergent mixture. Random sampling was assured by measuring the first 50 conidia encountered in the mount, usually in the first two or three microscope fields observed.

Conidia from twenty isolates of C. beticola taken from B. vulgaris from Monona County during 1965 and 1966 were thus measured. Mean conidial lengths are recorded in Tables 2 and 3. Though length of conidia ranged from 134.4 to 281.6μ, mean lengths of 50 conidia per isolates ranged from 202.6μ to 209.3μ.

Obviously, the means were taken from a single species population. Furthermore, these means are similar to those reported by others for C. beticola (Vestal, 43; Nagel, 27).

Tentatively, it would appear that one Cercospora species

Table 2. Mean lengths of 50 conidia from 20 Monona County isolates of Cercospora beticola Sacc.; with probable errors of means (above) and individual measurements (below)

Isolate No.	Mean length	Isolate No.	Mean length
1	± 3.4μ 207.93μ ± 24.2μ	11	± 4.8μ 205.9μ ± 34.5μ
2	± 4.9μ 204.8μ ± 35.1μ	12	± 4.7μ 207.0μ ± 33.9μ
3	± 4.1μ 202.6μ ± 29.8μ	13	± 4.9μ 207.7μ ± 35.0μ
4	± 4.7μ 207.0μ ± 33.9μ	14	± 4.7μ 207.0μ ± 33.9μ
5	± 4.8μ 209.3μ ± 34.4μ	15	± 4.9μ 208.0μ ± 35.2μ
6	± 4.8μ 204.8μ ± 34.2μ	16	± 4.9μ 209.1μ ± 35.3μ
7	± 5.1μ 204.0μ ± 36.1μ	17	± 4.4μ 207.3μ ± 31.8μ
8	± 4.7μ 205.8μ ± 33.9μ	18	± 4.3μ 206.8μ ± 30.6μ
9	± 4.8μ 204.5μ ± 34.7μ	19	± 4.9μ 207.0μ ± 34.9μ
10	± 4.9μ 207.7μ ± 35.0μ	20	± 5.5μ 206.2μ ± 39.3μ

Table 3. Analysis of variance of conidial length measurements summarized in Table 2

Source of variation	Degrees of freedom	Sum square	Mean sum square	F
Isolate	19	271.65	14.2974	0.0624
Error	980	224616.52	229.2005	
Total	999			

Model used for the above analysis of variance table:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij} ,$$

when

α_i = isolate effect

i = 1-20

j = 1-50

$\varepsilon_{ij} \sim$ NID $(0,\sigma^2)$

was causing leaf spot of sugar beets in Monona County in 1965 and 1966, that it was typical C. beticola, and that among 20 isolates, none were noticeably aberrant in length of conidia formed. Cursory examination of at least 25 other isolates also revealed no obvious deviates from C. beticola.

A typical isolate of C. beticola was inoculated on P. aviculare, P. pennsylvanicum and P. persicaria. After three to four days, conidia were taken from typical spots on each host, mounted and a sample of 50 were measured. In all, this was done five times from each host. All 15 means of conidial lengths were typical for C. beticola (Tables 4 and 5).

Similarly, C. avicularis, C. polygonorum and C. persicariae were inoculated to sugar beets and samples of 50 conidia from each of five spots induced by each species were measured. In each case, the ten means of conidial lengths were more or less typical for the Cercospora species which had been used for inoculum, the range being the same (Tables 6 to 11).

Thus it appears that in 1965 and 1966 in Monona County, C. beticola was the only Cercospora species occurring on sugar beets and that C. avicularis, C. polygonorum and C. persicariae were occurring on P. aviculare, P. pennsylvanicum and P. persicaria, respectively (Plate 1). The supplementary evidence indicates that had C. beticola been occurring on the three Polygonum species, or had their three respective

Table 4. Mean lengths[a] of 50 conidia of a C. beticola isolate on B. vulgaris and three Polygonum species; with probable errors of means (above) and individual measurements (below)

Inoculations	Hosts			
	Beta vulgaris L.	Polygonum aviculare L.	Polygonum pennsylvanicum L.	Polygonum persicaria L.
	± 3.4μ	± 4.25μ	± 4.69μ	± 4.82μ
1	207.93μ ± 24.2μ	208.76μ ± 30.2μ	206.97μ ± 33.3μ	211.5μ ± 34.2μ
		± 4.92μ	± 4.70μ	± 5.07μ
2		205.5μ ± 34.9μ	203.3μ ± 33.4μ	210.2μ ± 36.0μ
		± 4.87μ	± 4.76μ	± 4.92μ
3		206.3μ ± 34.6μ	206.5μ ± 33.8μ	208.3μ ± 34.9μ
		± 4.97μ	± 4.77μ	± 5.00μ
4		203.5μ ± 35.3μ	207.0μ ± 33.9μ	210.4μ ± 35.5μ
		± 5.06μ	± 4.77μ	± 4.94μ
5		203.3μ ± 35.9μ	206.8μ ± 33.9μ	205.7μ ± 34.96μ

[a]Mean lengths of C. beticola measured from cultured slants and inoculated on hosts. Later, lesions teased and conidia remeasured.

Table 5. Analysis of variance of conidial length measurements summarized in Table 4

Source of variation	Degrees of freedom	Sum square	Mean sum square	F
Species	2	128.676	64.338	3.5352
Error	12	218.384	18.199	
Total	735			

Model used for the above analysis of variance table:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij} ,$$

when

α_i = species effect

$i = 1,2,3$

$j = 1,2 \cdots 5$

$\varepsilon_{ij} \sim NID(o,\sigma^2)$

Table 6. Mean lengths of 50 conidia of C. avicularis taken from P. aviculare and from B. vulgaris; with probable errors of means (above) and individual measurements (below)

C. avicularis isolates from:	Isolate No.	Lengths of conidia of C. avicularis taken from: Cultures from P. aviculare	Inoculated B. vulgaris leaves
Monona County	1	± 1.8μ 63.9μ ± 13.1μ	± 1.9μ 61.9μ ± 13.5μ
	2	± 1.8μ 64.9μ ± 12.9μ	± 1.6μ 62.2μ ± 11.1μ
	3	± 1.9μ 66.2μ ± 13.7μ	± 1.8μ 65.98μ ± 13.1μ
	4	± 1.9μ 64.5μ ± 13.2μ	± 1.9μ 64.77μ ± 13.2μ
	5	± 1.8μ 64.9μ ± 12.8μ	± 1.8μ 64.3μ ± 12.6μ
	6	± 1.8μ 64.3μ ± 13.1μ	± 1.98μ 65.3μ ± 13.94μ
	7	± 1.8μ 64.5μ ± 12.7μ	± 1.8μ 64.6μ ± 12.9μ
	8	± 1.8μ 64.8μ ± 12.9μ	± 1.8μ 64.8μ ± 12.9μ
	9	± 1.8μ 64.8μ ± 12.9μ	± 1.8μ 65.6μ ± 12.9μ
	10	± 1.8μ 64.2μ ± 12.6μ	± 1.7μ 64.6μ ± 12.4μ
	NOTE	Range of spore 38.4μ - 96.0μ	38.4μ - 96.0μ

Table 6. (continued)

C. avicularis Isolates from:	Isolate No.	Lengths of conidia of C. avicularis taken from: Cultures from P. aviculare	Inoculated B. vulgaris leaves
Story County	1	± 1.8μ 61.95μ ± 12.6μ	± 1.8μ 61.95μ ± 12.6μ
	2	± 1.6μ 61.8μ ± 10.97μ	± 1.6μ 63.6μ ± 11.5μ
	3	± 1.6μ 62.4μ ± 11.6μ	± 1.6μ 62.7μ ± 11.6μ
	4	± 1.6μ 62.0μ ± 11.3μ	± 1.6μ 62.2μ ± 11.3μ
	5	± 1.7μ 62.3μ ± 11.8μ	± 1.7μ 62.3μ ± 11.8μ
	NOTE	Range of spore 38.4μ - 96.0μ	38.4μ - 96.0μ

Table 7. Analysis of variance of conidial length measurements of C. avicularis summarized in Table 6

Source of variation	Degrees of freedom	Sum square	Mean sum square	F
Location	1	159.16	159.16	38.96**
Host	1	0.0004	0.0004	
Location x host	1	3.9610	3.9610	
Error	26	106.2020	4.0847	
Sampling error	1470	45677.6600	31.0732	
Total	1499			

**Significant at the 1 percent level.

Model used for the above analysis of variance table:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} ,$$

when

α = location, i = 1,2

β = host, j = 1,2

k = 1-10, i = 1
1-5, i = 2

$\varepsilon_{ijk} \sim$ NID $(0,\sigma^2)$

Table 8. Mean lengths of 50 conidia of C. persicariae taken from P. persicaria and B. vulgaris; with probable errors of means (above) and individual measurements (below)

C. persicariae isolates from:	Isolate No.	Lengths of conidia of C. persicariae taken from: Cultures from P. persicaria	Inoculated B. vulgaris leaves
Monona County	1	± 4.4μ 108.4μ ± 31.4μ	± 4.4μ 108.6μ ± 31.3μ
	2	± 4.5μ 112.9μ ± 31.97μ	± 4.5μ 113.9μ ± 31.8μ
	3	± 4.7μ 111.7μ ± 33.1μ	± 4.7μ 111.8μ ± 33.2μ
	4	± 4.8μ 113.7μ ± 34.0μ	± 4.8μ 114.2μ ± 34.4μ
	5	± 4.9μ 116.7μ ± 34.5μ	± 4.9μ 117.2μ ± 34.8μ
	6	± 4.4μ 116.1μ ± 31.4μ	± 4.5μ 116.7μ ± 31.8μ
	7	± 4.5μ 113.3μ ± 31.97μ	± 4.5μ 113.6μ ± 31.9μ
	8	± 4.5μ 113.3μ ± 31.9μ	± 4.5μ 113.3μ ± 31.99μ
	9	± 4.5μ 113.2μ ± 32.0μ	± 4.5μ 113.52μ ± 32.0μ
	10	± 4.5μ 113.3μ ± 31.9μ	± 4.5μ 112.96μ ± 32.12μ
	NOTE	Range of spore 70.4μ - 211.2μ	70.4μ - 211.2μ

Table 8. (continued)

C. persicariae isolates from:	Isolate No.	Lengths of conidia of *C. persicariae* taken from: Cultures from *P. persicaria*	Inoculated *B. vulgaris* leaves
Story County	1	± 4.5μ 105.98μ ± 31.7μ	± 4.4μ 106.6μ ± 31.5μ
	2	± 4.3μ 104.4μ ± 30.2μ	± 4.7μ 114.8μ ± 33.5μ
	3	± 4.5μ 104.5μ ± 32.3μ	± 4.3μ 103.6μ ± 30.6μ
	4	± 4.5μ 106.6μ ± 32.1μ	± 4.5μ 106.9μ ± 31.6μ
	5	± 4.5μ 106.6μ ± 31.97μ	± 4.5μ 106.8μ ± 31.8μ
	NOTE	Range of spore 70.4μ - 211.2μ	70.4μ - 211.2μ

Table 9. Analysis of variance of conidial length measurements of C. persicariae summarized in Table 8

Source of variation	Degrees of freedom	Sum square	Mean sum square	F
Location	1	1474.203	1474.203	183.99**
Host	1	30.814	30.814	
Location x host	1	26.699	26.699	
Error	26	208.318	8.012	
Sampling error	1470	304549.90	207.1768	
Total	1499			

**Significant at the 1 percent level.

Model used for the above analysis of variance table:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} ,$$

when

α = location, i = 1,2

β = host, j = 1,2

k = 1-10, i = 1
1-5, i = 2

$\varepsilon_{ijk} \sim$ NID $(0,\sigma^2)$

Table 10. Mean lengths of 50 conidia of C. polygonorum taken from P. pennsylvanicum and B. vulgaris; with probable errors of means (above) and individual measurements (below)

C. polygonorum isolates from:	Isolate No.	Lengths of conidia of C. polygonorum taken from: Cultures from P. pennsylvanicum	Inoculated B. vulgaris leaves
Monona County	1	± 5.23μ 124.6μ ± 36.98μ	± 5.51μ 125.5μ ± 39.1μ
	2	± 5.13μ 120.2μ ± 36.4μ	± 5.23μ 124.99μ ± 37.1μ
	3	± 5.15μ 119.8μ ± 36.6μ	± 5.11μ 119.4μ ± 36.3μ
	4	± 5.13μ 120.3μ ± 36.4μ	± 5.08μ 120.5μ ± 36.1μ
	5	± 5.099μ 119.7μ ± 36.2μ	± 5.14μ 118.8μ ± 36.5μ
	6	± 5.11μ 120.4μ ± 36.3μ	± 4.99μ 119.1μ ± 35.4μ
	7	± 5.08μ 120.8μ ± 36.1μ	± 5.15μ 120.7μ ± 36.6μ
	8	± 5.14μ 119.9μ ± 36.5μ	± 5.15μ 119.9μ ± 36.6μ
	9	± 5.31μ 123.3μ ± 37.7μ	± 4.197μ 120.1μ ± 29.8μ
	10	± 5.14μ 119.4μ ± 36.5μ	± 5.13μ 119.3μ ± 36.4μ
	NOTE	Range of spore 70.4μ - 224.0μ	70.4μ - 224.0μ

Table 10. (continued)

C. polygonorum isolates from:	Isolate No.	Lengths of conidia of C. polygonorum taken from: Cultures from P. pennsylvanicum	Inoculated B. vulgaris leaves
Story County	1	± 5.37μ 117.8μ ± 37.97μ	± 5.37μ 117.89μ ± 37.96μ
	2	± 5.32μ 119.3μ ± 37.8μ	± 5.48μ 121.2μ ± 28.9μ
	3	± 5.37μ 118.0μ ± 37.99μ	± 5.296μ 117.6μ ± 37.6μ
	4	± 5.03μ 115.3μ ± 35.7μ	± 5.03μ 115.4μ ± 35.7μ
	5	± 5.37μ 117.6μ ± 38.1μ	± 5.35μ 117.8μ ± 38.0μ
	NOTE	Range of spore 70.4μ - 224.0μ	70.4μ - 224.0μ

Table 11. Analysis of variance of conidial length measurements of C. polygonorum summarized in Table 10

Source of variation	Degrees of freedom	Sum square	Mean sum square	F
Location	1	304.009	304.009	15.5193**
Host	1	0.560	0.560	
Location x host	1	1.009	1.009	
Error	26	509.322	19.589	
Sampling error	1470	400606.820	272.5216	
Total	1499			

**Significant at the 1 percent level.

Model used for the above analysis of variance table:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} ,$$

when

α = location, i = 1,2

β = host, j = 1,2

k = 1-10, i = 1
1-5, i = 2

$\varepsilon_{ijk} \sim$ NID $(0,\sigma^2)$

Plate 1. Camera lucida drawings of conidia of species of Cercospora from following hosts obtained from cultures:

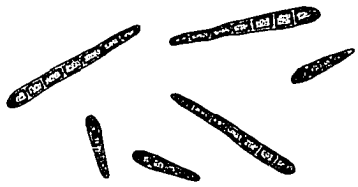
C. avicularis from P. aviculare

C. beticola from B. vulgaris

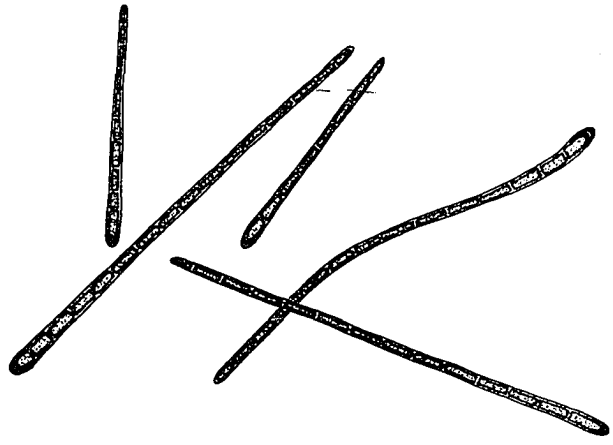
C. persicariae from P. persicaria

C. polygonorum from P. pennsylvanicum

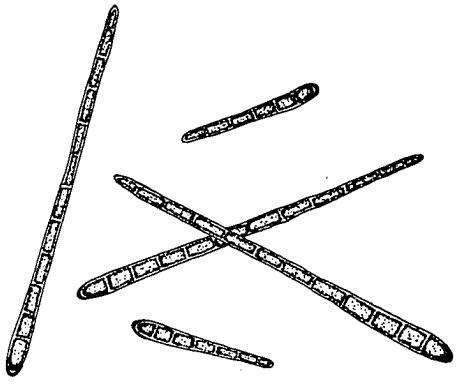
C. avicularis



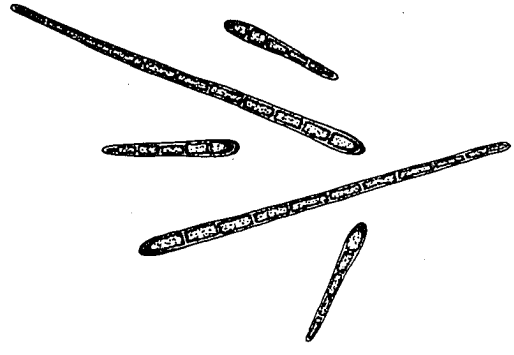
C. beticola



C. persicariae



C. polygonorum



50u

Cercospora species been occurring on sugar beets, they would have been readily detectable on the basis of mean length of conidia.

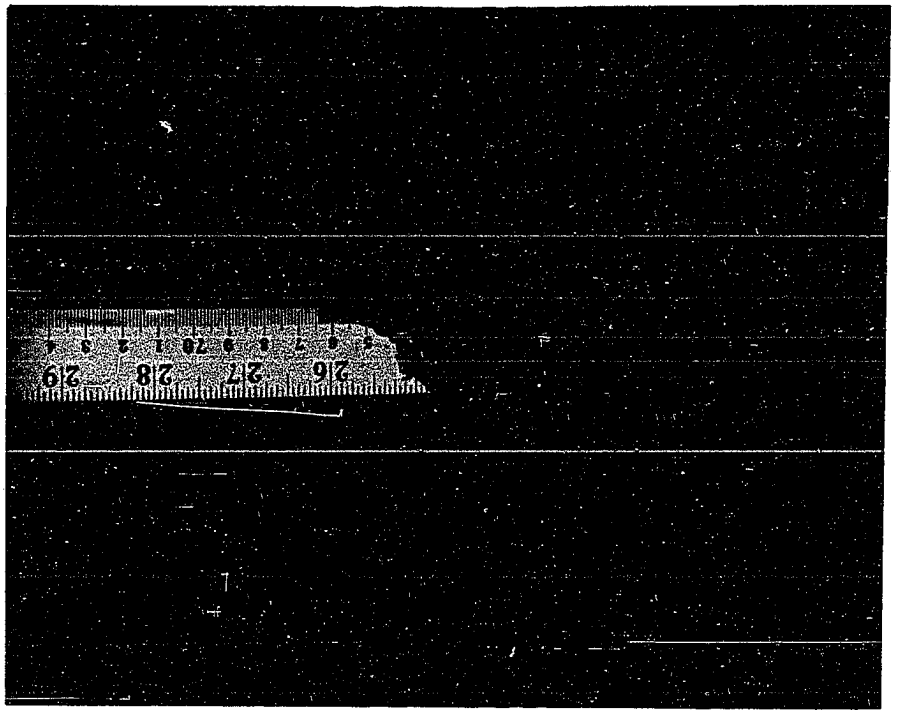
Conidia from five isolates each of C. avicularis, C. polygonorum and C. persicariae from Story County were also measured. When compared species for species, mean lengths of conidia of Story County isolates were for all three species less than those of the respective Monona County isolates (Tables 6 to 11). On each host, symptoms, however, were similar in the two localities (Plates 2 to 9, inclusive).

Statistical analysis of data on conidial measurements indicates and confirms:

1) All twenty isolates of C. beticola belong to one and the same species.
2) When an isolate of C. beticola was inoculated to the Polygonaceous weeds and re-measured, there was no significant difference in conidial length measurements, confirming the originality of the fungus.
3) Similarly when C. avicularis, C. persicariae and C. polygonorum were inoculated to B. vulgaris and re-measured, in both Monona and Story Counties, there was no appreciable difference in conidial lengths when measured from cultures and when measured from sugar beets. However, mean lengths of conidia of isolates from both counties were significantly

Plate 2. Healthy plant of *Beta vulgaris* var *saccharita* L.

Plate 3. Diseased plant of *Beta vulgaris* var *saccharita* L. with leaf spots of *Cercospora beticola* Sacc.


26 27 28 29

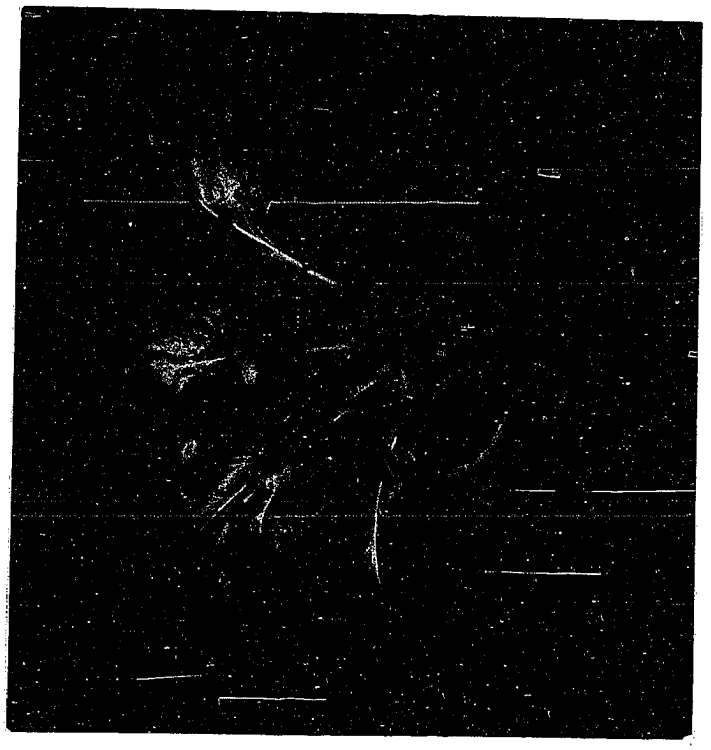
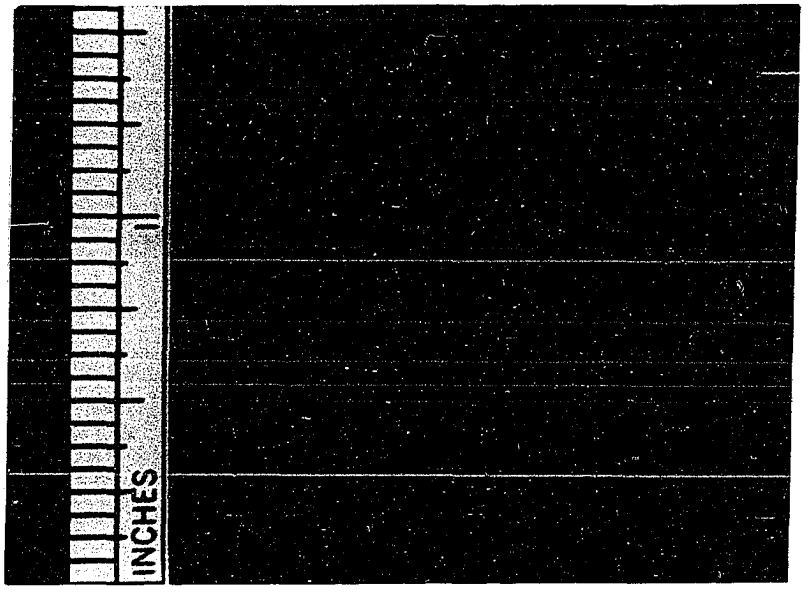


Plate 4. Healthy plant of *Polygonum aviculare* L.

Plate 5. Diseased leaves of *Polygonum aviculare* L. with leaf spots of *Cercospora avicularis* Wint.


INCHES
1

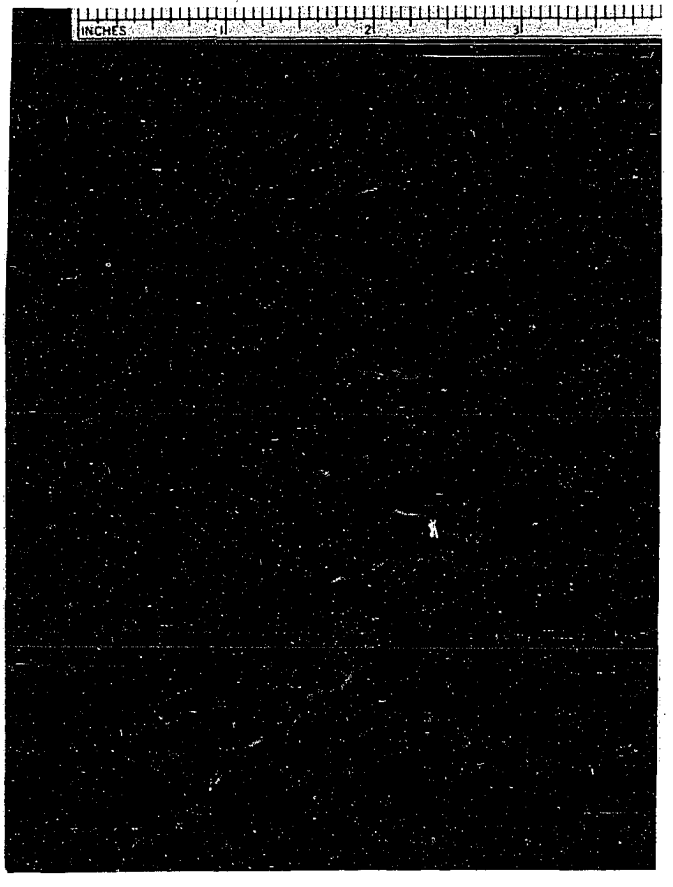
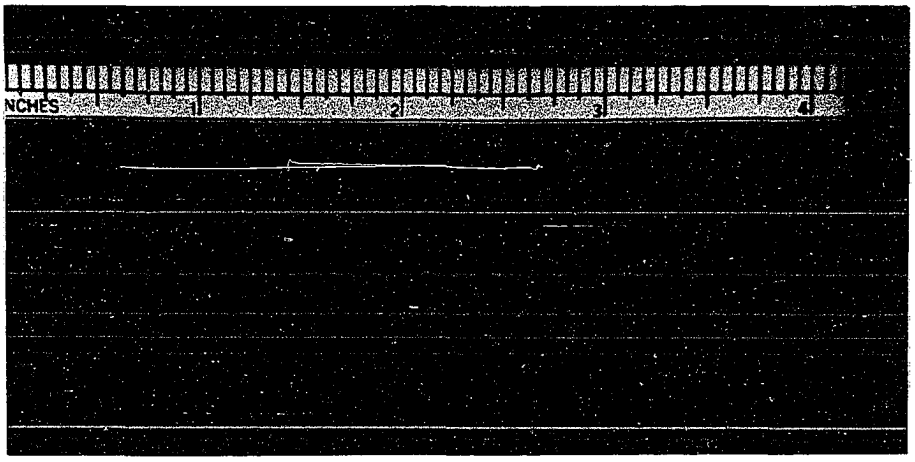

INCHES
1
2
3

Plate 6. Healthy plant of *Polygonum pennsylvanicum* L.

Plate 7. Diseased leaf of *Polygonum pennsylvanicum* L. with leaf spots of *Cercospora polygonorum* Cke.


INCHES
1
2
3
4

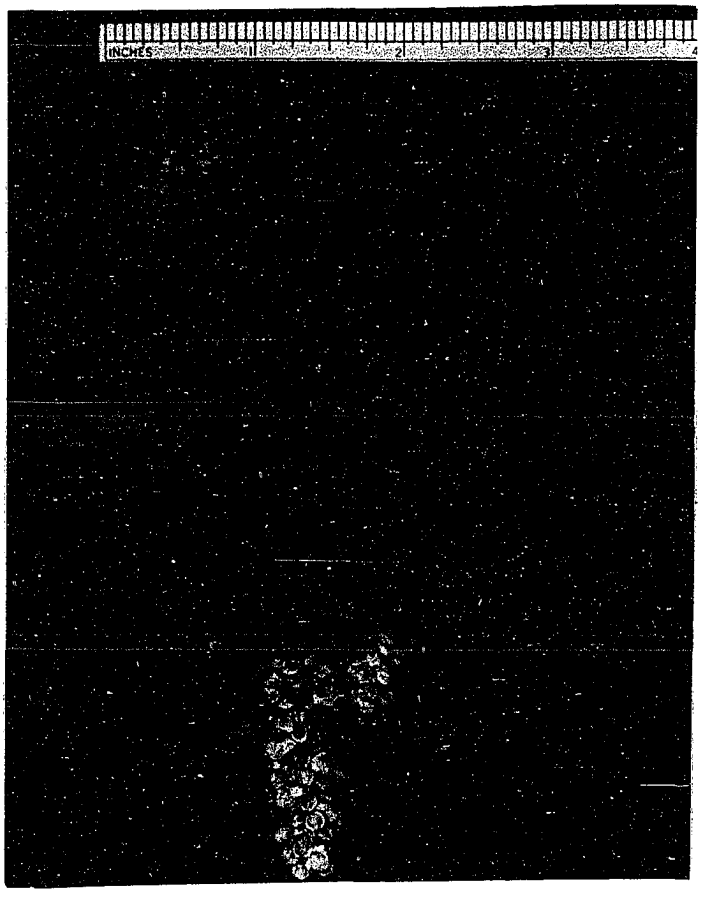
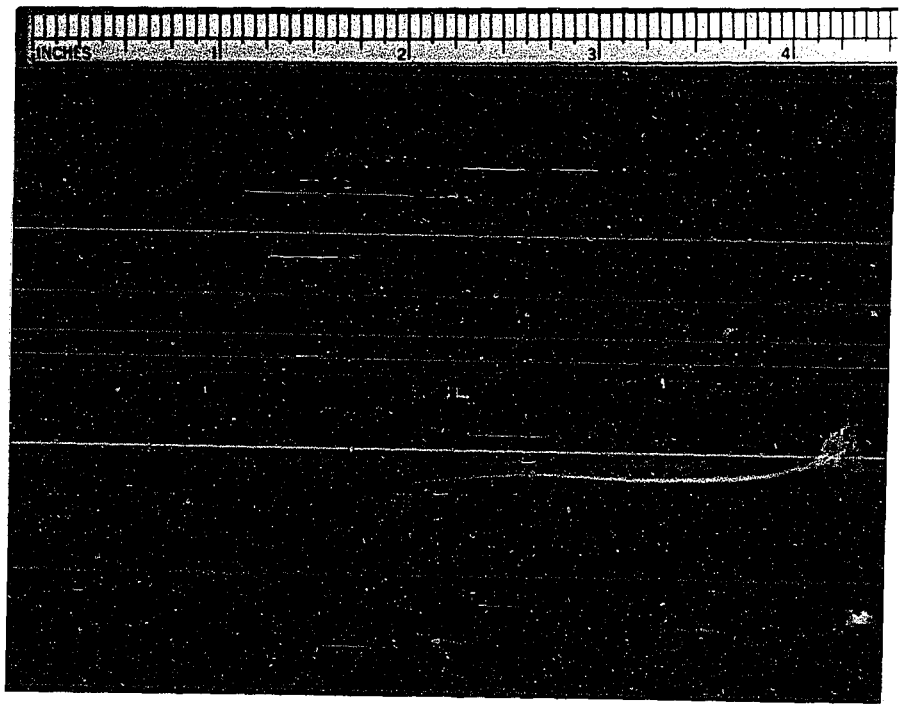

INCHES
1
2
3

Plate 8. Healthy plant of *Polygonum persicaria* L.

Plate 9. Diseased leaves of *Polygonum persicaria* L. with leaf spots of *Cercospora persicariae* Yamamoto


INCHES
1
2
3
4

different, even though range of conidial lengths were the same.

C. Morphological Barriers to Penetration of C. Beticola

No Cercospora spot was found on the many leaves of P. coccineum examined in field collections. Furthermore, not a single spot developed as a result of inoculation of this species with C. beticola in the greenhouse. P. coccineum was the only one of 11 species of Polygonaceae and Chenopodiaceae for which both of these statements were true. An effort was made histologically to ascertain what was involved in P. coccineum not being a host for C. beticola or some other species of Cercospora. Precisely, the effort was directed at ascertaining whether there was lack of host penetration by germ tubes of the fungus or whether there was failure of establishment within the host after penetration. In both respects, procedures involved in study were duplicated with sugar beets on which C. beticola gains normal entrance and in which establishment proceeds after penetration.

Healthy sugar beet and P. coccineum leaves were inoculated with C. beticola. Portions of inoculated leaves were placed in fixative 24 hours, three days and five days after inoculation. Following by dehydration, infiltration with paraffin, and finally preparation of paraffin blocks, microtome sections were made and stained with safranin,

counterstained with fast green, dehydrated, and mounted in Canada balsam.

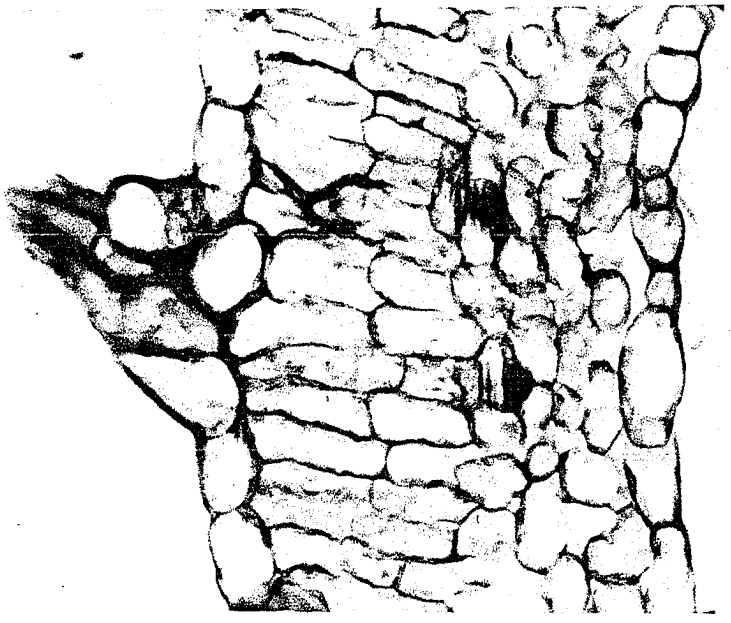
This procedure did not result in material from which it was possible to follow the entrance of the pathogen into the host. It did, however, indicate a feature of the leaf surface of P. coccineum which may prevent its being a host for Cercospora.

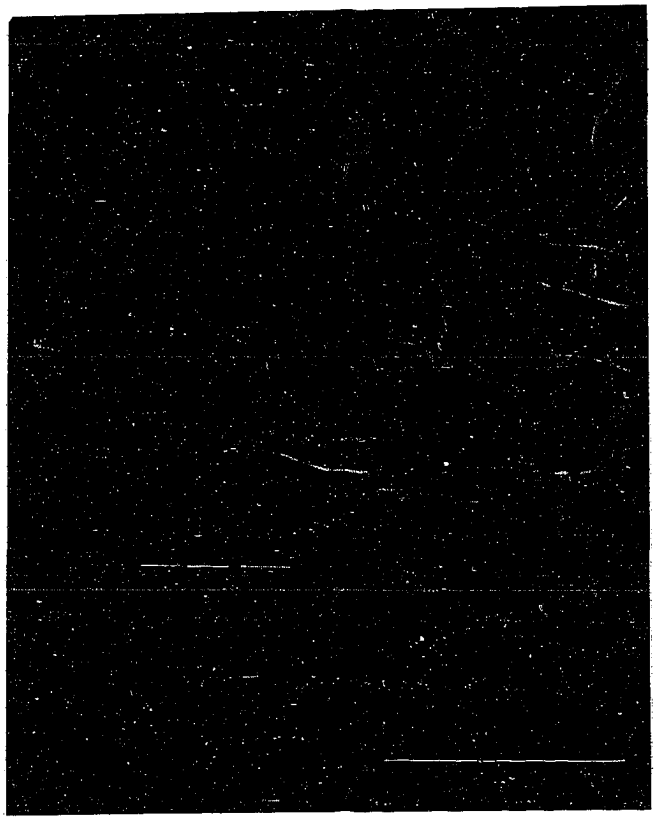
Microtome sections of P. coccineum, as well as epidermal strip mounts, clearly indicated the presence of trichomes on the epidermis of the leaf (Plates 10 and 11). These trichomes were large enough to be visible to the naked eye. In addition the entire plant seemed to be covered with some secretion which gave it a dull appearance. In contrast, free hand sections of plants of three species of Polygonum that were hosts for C. beticola—namely, P. aviculare, P. pennsylvanicum, and P. persicaria—revealed complete absence of trichomes and any secretory substance. Similarly, microtome sections and epidermal strip mounts of B. vulgaris leaves were completely lacking in trichomes.

It seems likely that the abundant, large trichomes on the leaf surface prevent contact of conidia of C. beticola with the leaf of P. coccineum and thus interfere with penetration of germ tubes into the leaf. This likelihood is enhanced by the complete absence of trichomes on leaves of B. vulgaris, P. aviculare, P. pennsylvanicum and P. persicaria, all hosts

Plate 10. Plant of Polygonum coccineum Muhl.

Plate 11. Photomicrograph of a transverse section of a leaf of Polygonum coccineum Muhl., showing a trichome under high power magnification (4250X)





of C. beticola.

D. Direct Penetration of the Cuticle of B. Vulgaris Leaves by C. Beticola

When a method—to be described below—suitable for observation of penetration of host leaves by C. beticola was finally mastered, the observations themselves were different than those recorded by other investigators.

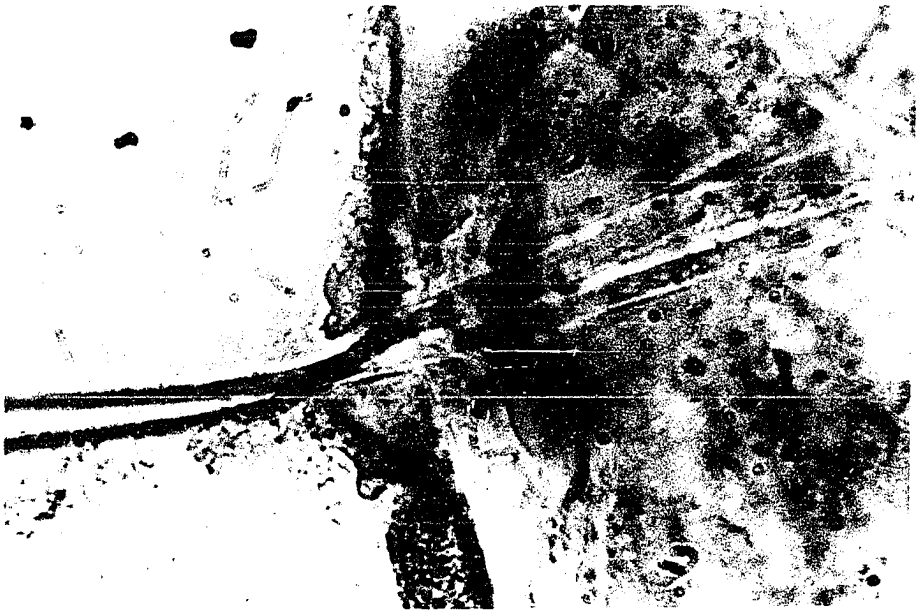
Germination of conidia and the penetration of germ tubes of C. beticola through open stomates of sugar beet was observed by Vestal (43) and Canova (5). Observations to be recorded here indicate that direct penetration through the cuticle may be of common occurrence.

Conidia of C. beticola were placed on designated areas on leaves of sugar beet seedlings which were in turn placed in water in petri dishes. At various time intervals, portions of epidermis on which conidia had been placed were removed with a sharp razor and placed, right side up, on a glass slide in Meyer's egg albumin fixative. Slides were dried, flooded with cotton blue in lactophenol for one minute. They were then washed with distilled water and the specimen counterstained with erythrosin and mounted in glycerine. The procedure was repeated several times and various observations recorded in photomicrographs and drawings (Plates 12 to 17). All drawings are free hand and true to scale as far as possible.

Four instances are depicted (Plate 14, Figures A, B, C

Plate 12. Photomicrograph showing penetration of the cuticle of B. vulgaris by germ tube of C. beticola (1700X)

Plate 13. The same under oil immersion (4250X)



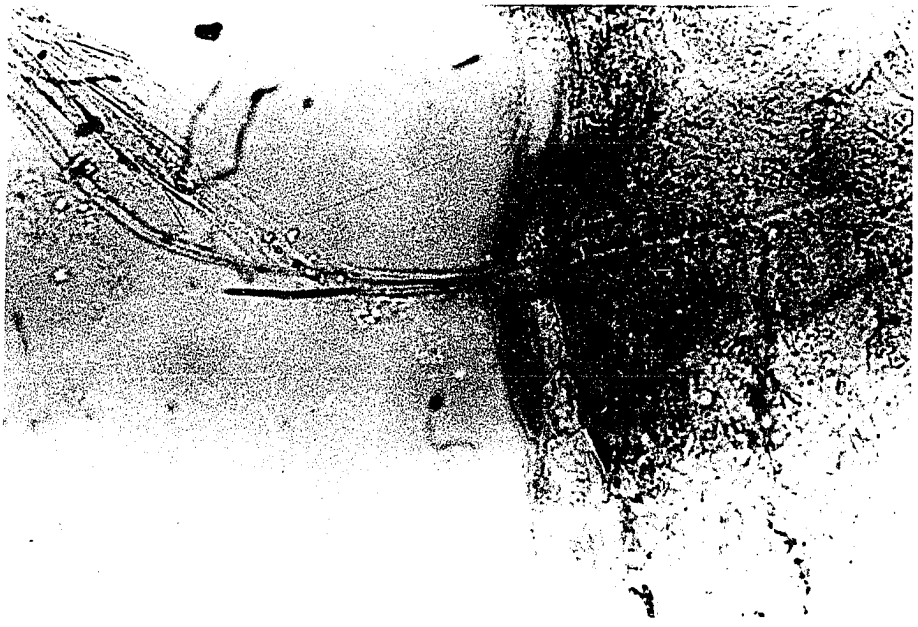
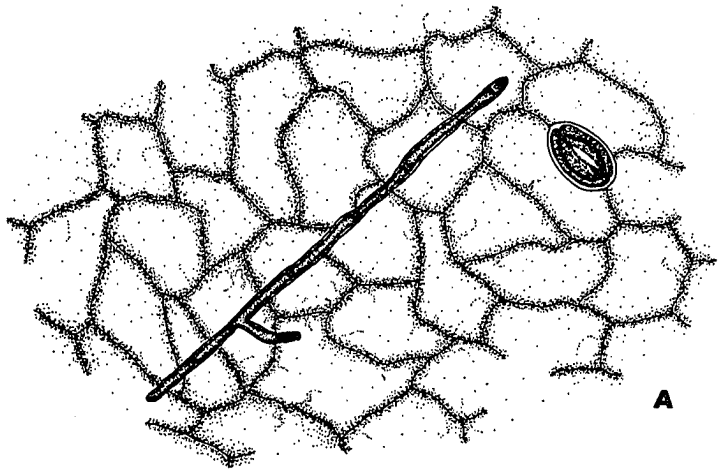


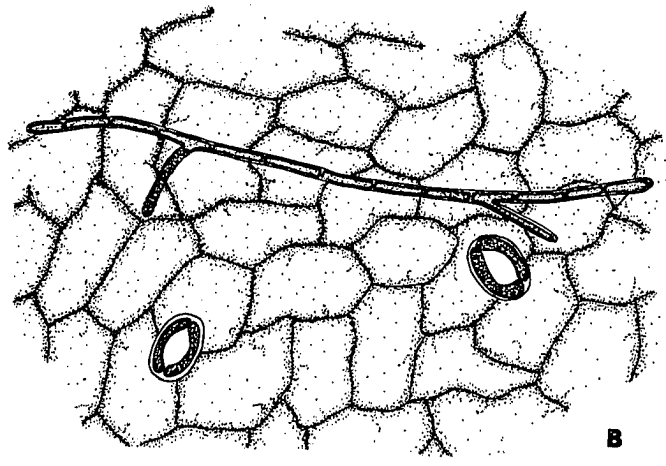
Plate 14. Direct penetration of germ tubes of C. beticola into leaves of B. vulgaris as observed in an epidermal strip as seen through a microscope (430X)

Figure A. Dark shaded bent portion of the germ tube is the portion that has penetrated the host

Figure B. Germ tube on the left has penetrated the host cells, but a second one on the right grows away from a nearby open stomate

Figure C. A germinating conidium lies right across an open stomate; germ tube on the right grows away from an open stomate, whereas the one on the left penetrates in directly


A


B

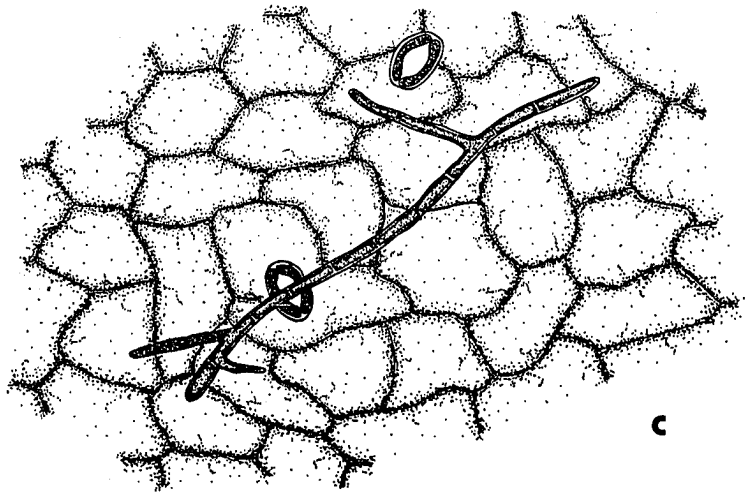
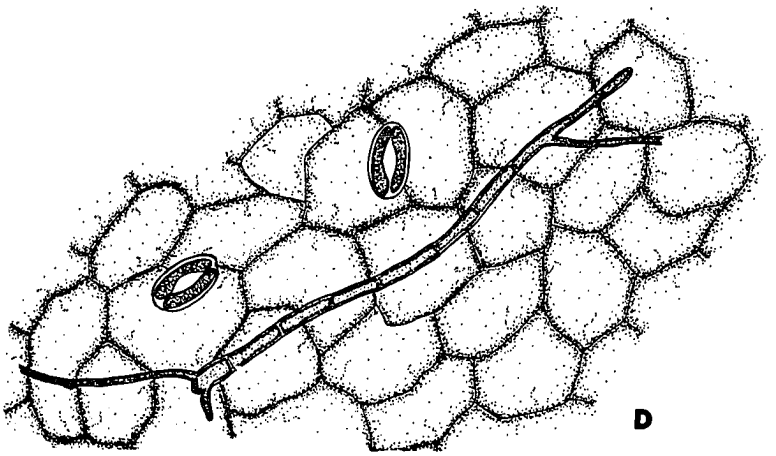

C

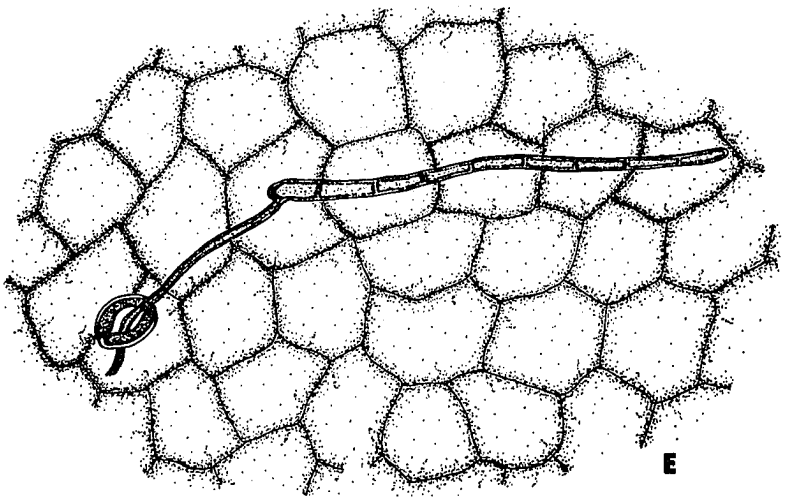
Plate 15. Direct penetration of germ tubes of *C. beticola* into leaves of *B. vulgaris* as observed in an epidermal strip as seen through a microscope (430X)

Figure D. Evidence of direct penetration is seen in the case of both the germ tubes

Figure E. An incidence of stomatal penetration

Figure F. A case of stomatal penetration (lower left germ tube) and direct penetration (upper right germ tube)


D


E

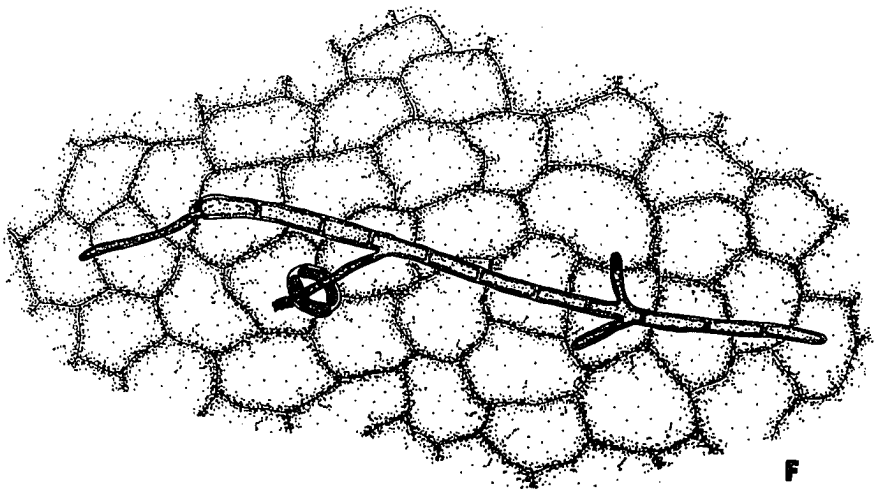
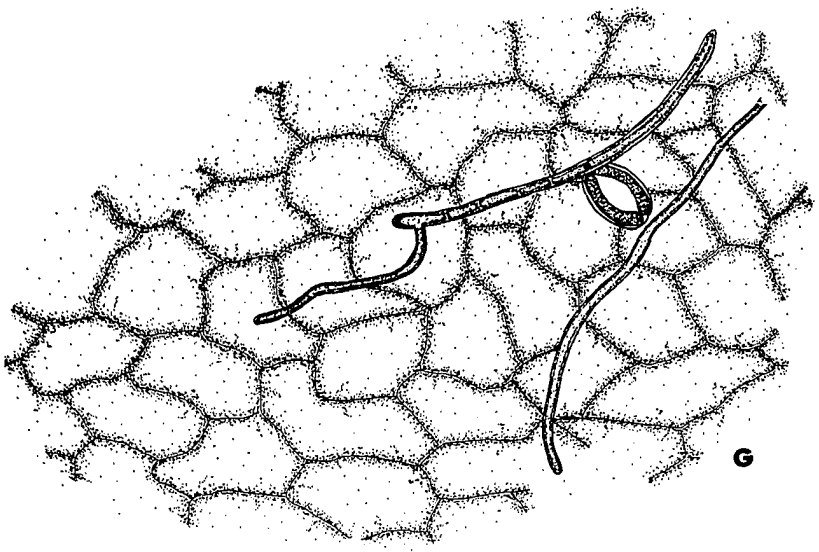

F

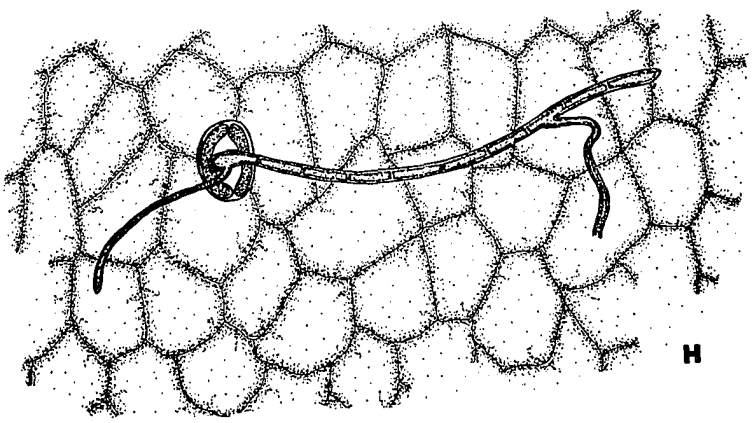
Plate 16. Direct penetration of germ tubes of C. beticola into leaves of B. vulgaris as observed in an epidermal strip as seen through a microscope (430X)

Figure G. Indirect evidence of direct penetration deduced from figures indicating germ tubes growing away from open stomates

Figure H. A conidium cradled in an open stomate with germ tubes growing in another direction

Figure I. A number of germ tubes emerging from a conidium but none enter the stomate


G


H

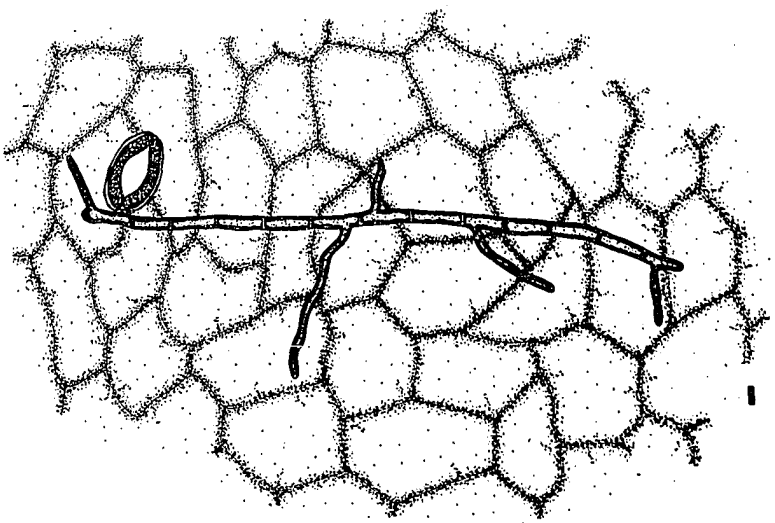
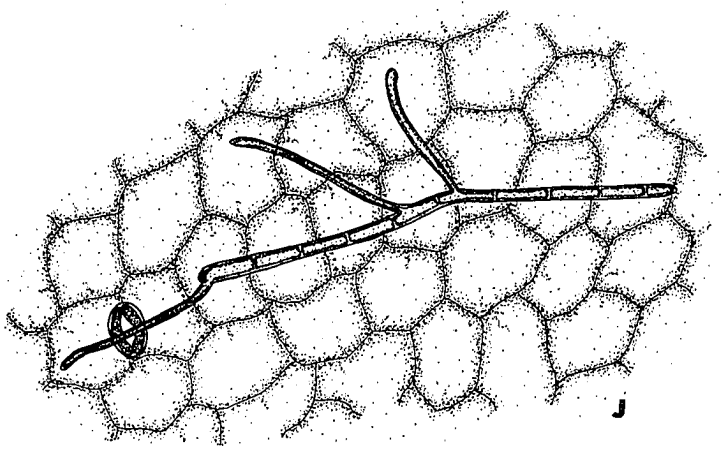

I

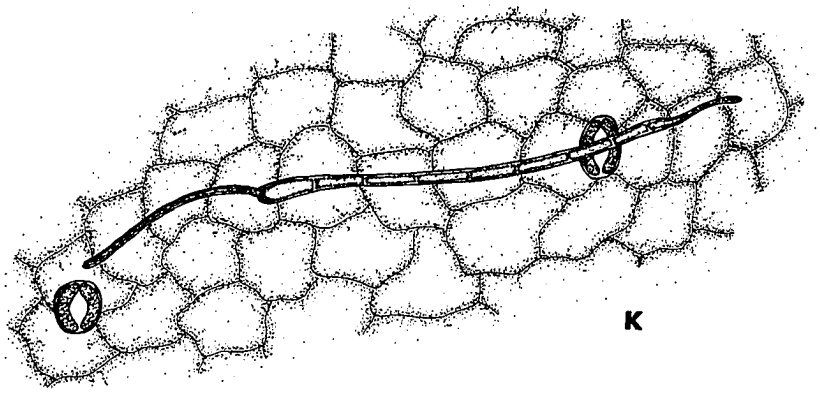
Plate 17. Direct penetration of germ tubes of *C. beticola* into leaves of *B. vulgaris* as observed in an epidermal strip as seen through a microscope (430X)

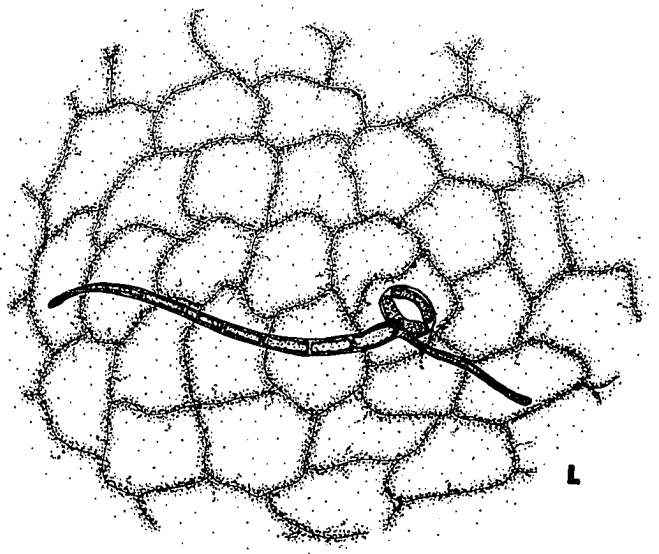
Figure J. Evidence of a germ tube growing right across an open stomate

Figure K. A probable instance of a germ tube approaching an open stomate

Figure L. Another instance of a cradled conidium with the germ tube diverting to another direction


J


K


L

and Plate 15, Figure D) where distinct penetration through cell walls was observed. In most cases penetration appeared to be in between two cells, by germ tube, distinguishable due to lack of septa. In Plate 14, Figure A penetration has occurred at a point where germ tube is 176.0μ away from a stoma. In Plate 14, Figure B, there is emission of two germ tubes of which one has penetrated directly with an open stoma at a distance of 112.0μ. The second germ tube, however, grows away from an open stoma situated at a distance of 32.0μ.

A third case was observed in Plate 14, Figure C, where the conidium lay right across an open stoma. It produced three germ tubes, one of which penetrated directly through the cuticle in between cells, another grew 22.4μ away from another open stoma and a third was just emerging. Direct penetration through the cuticle occurred at a distance of 64.0μ from a stoma.

In another slide in Plate 15, Figure D, germination of a conidium of C. beticola resulted in three germ tubes, none of which entered a stoma. On the other hand, one of the germ tubes penetrated the cuticle directly.

Entrance of germ tubes through stomata were observed in two cases in Plate 15, Figures E and F, but in one case (Figure F) a second germ tube indicated direct penetration, further testifying to the ability of germ tubes to penetrate through the cuticle commonly.

Indirect evidence of direct penetration was obtained from more than ten instances of germ tubes growing away from or over stomates. In Plate 16, Figure H clearly depicts a conidium cradled in a stoma with the germ tube growing out and away from the stoma. Similar evidence is presented in Plate 17, Figure L. In Plate 16, Figures G and I are instances where germ tubes grow away from stoma; in addition, however, in Plate 17, Figure J is an interesting case where germ tube grows right across an open stoma.

IV. DISCUSSION

It was necessary in the beginning of this investigation to have a good knowledge of the flora of the Missouri River flood plains in order to study the host range of C. beticola. Frequent visits to Des Moines, Onawa and the outskirts of Ames revealed the abundant occurrence of plants belonging to families Chenopodiaceae and Polygonaceae. A flora (26) of these areas confirmed the same, and with this knowledge selection of plants was made.

Studies on host range not only indicate the ability of a fungus to attack other hosts, but also a probable over-wintering place. During the course of this study, plants of Fagopyrum sagittatum Gilib., Kochia scoparia L., Polygonum aviculare L., P. persicaria L., and Salsola kali L. were all observed to be new hosts for C. beticola (19). This finding led to the study of comparison of flora of a sugar beet and non-sugar beet growing area.

A great abundance of plants of P. aviculare, P. coccineum, P. pennsylvanicum, and P. persicaria was observed in the sugar beet growing area of Monona County and non-sugar beet growing area of Story County. As all the three were experimental hosts for C. beticola, an effort was made to collect such diseased plants from both localities and identify the fungus on them. When this part of the investigation was undertaken, it was postulated that all the three Polygonum spp. probably

had three different Cercosporas on them, but that the fungus on the three Polygonums was the same in both localities.

This assumption was made, not only on morphological manifestation of the fungus evident from field as well as herbarium specimens and photographs, but based also on cultural characteristics and conidial measurements. In spite of the fact that range of conidial measurements was the same for both the localities in the case of all three Cercosporas on the three Polygonums, mean conidial lengths of fungus from Monona County collections were longer than the Story County collections.

It is quite possible, however, that C. beticola from Beta vulgaris var saccharita L. survived on the Polygonaceous hosts when beets were not on the field and re-infected beets when they were planted. But the appearance of Cercospora leaf spots during the first year beets were grown in Monona County poses the problem of original source conidia of C. beticola. An assumption might answer this question.

The Polygonaceous hosts existed long before beets were grown in those areas. Each plant species had a particular species of Cercospora, further ascertained by the Cercospora species on those same plants in non-sugar beet growing areas. It could be possible that one of the Cercosporas on the three Polygonaceous hosts was capable of becoming established on B. vulgaris and did so with the first planting of B. vulgaris

in that area. Enough data to this postulation is offered by conidial measurements where it is observed that a certain Cercospora species, when measured from its host, is smaller than when inoculated on B. vulgaris and then measured. It may be pointed out here that conidia of C. beticola from B. vulgaris are the longest ones observed.

Conidial measurements also indicate that conidia of the same species from Monona County are longer than the conidia of that same species of Story County. This increase in length of conidia from non-sugar beet growing area to sugar beet growing area, and ultimately from Polygonaceous hosts to Beta vulgaris, is suggestive of possible change of Cercosporas from Story County to Monona County, and from Polygonum spp. to Beta vulgaris in subsequent generations of the respective hosts. A possible question arises: Could there be plasticity of pathogenicity involved in outbreak of Cercospora leaf spot of B. vulgaris?

It may be of interest to point out here that late in the summer of 1966 collections of diseased B. vulgaris leaves were made from fields planted for the first time with this crop. Seven isolations were made, five of which were found to be C. beticola, the other two were mixed cultures. Further, vegetation neighbouring such fields was typically the same; namely, P. avicularia, P. coccineum, P. pennsylvanicum and P. persicaria.

The most abundant weedy plant in fields in Monona and Story Counties is Polygonum coccineum Muhl., but it completely failed to respond as a host for C. beticola during repeated trials. The plant is scabrous with strigose ocreae, pubescent and glandular peduncles and leaves. The pubescent and glandular characters are apparent on external appearance and, in microtome section of a leaf, stiff, pointed trichomes are visible. Failure of infection by C. beticola may possibly be attributed to these two features. Stiff, pointed hairs, very close to each other, could form a layer and prevent the conidia of C. beticola from juxtaposition with the epidermis, causing them to stay suspended above the leaf surface, exposed to adverse conditions. Presence of glands could keep the surface of the leaf covered with secretion, which might hinder conidial germination.

Very few instances of stomatal penetration by germ tube of C. beticola were observed; in most situations observed, the germ tube penetrated directly through the cuticle. In repeated experiments conducted over a period of two years, direct entry was the rule rather than the exception! In most cases the germ tube was observed to pierce through the cuticle and between cell walls of the host. It is quite possible intercellular spaces serve as portals of entrance, being the point of least obstruction and resistance. As these studies were carried out mainly to detect the method of penetration,

further growth of a germ tube was not followed, but evidence was obtained which clearly indicated direct penetration of germ tubes of C. beticola.

V. SUMMARY

Numerous hosts for C. beticola have been reported, of which plants of families Chenopodiaceae and Polygonaceae were of interest for this investigation. The possibility of such wild hosts harboring the fungus during the absence of B. vulgaris from the field was suggested and, with this in view, experiments were performed. An extension of host range of C. beticola was established with the inclusion of new hosts F. sagittatum, K. scoparia, P. aviculare, P. persicaria, and S. kali.

The possibility of these weeds having Cercospora species on them long before B. vulgaris was grown in Monona County, initiated the comparative study between Monona County and Story County—sugar beet and non-sugar beet growing areas. It was concluded that every evidence indicated a plasticity of pathogenicity during successive generations of weed hosts, as a result of which the Cercosporas on the weeds could have become parasitic on sugar beets.

Evidence was obtained indicating P. coccineum to be a non-host for C. beticola. Morphological and possibly chemical barriers may be responsible for such an exclusion.

Penetration of C. beticola into leaves of B. vulgaris had so far been reported to be only through open stomates. During the course of this investigation several observations

were made which confirmed this, but produced enough evidence to conclude stomatal entrance to be a chance and direct penetration through the cuticle to be a rule.

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VIII. APPENDIX

Table 12. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 1

No.	Length	No.	Length	No.	Length	No.	Length
1	84	14	68	27	64	40	48
2	56	15	43	28	52	41	42
3	76	16	68	29	88	42	43
4	67	17	42	30	84	43	88
5	64	18	48	31	76	44	84
6	52	19	76	32	48	45	76
7	88	20	52	33	43	46	67
8	48	21	48	34	42	47	64
9	46	22	48	35	45	48	76
10	46	23	76	36	84	49	64
11	66	24	85	37	76	50	67
12	45	25	67	38	64		
13	85	26	76	39	76		

Table 13. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 2

No.	Length	No.	Length	No.	Length	No.	Length
1	67	14	43	27	85	40	76
2	64	15	88	28	76	41	64
3	52	16	76	29	64	42	67
4	88	17	64	30	76	43	57
5	67	18	48	31	42	44	56
6	76	19	43	32	84	45	84
7	88	20	42	33	52	46	68
8	48	21	84	34	46	47	45
9	52	22	43	35	45	48	85
10	84	23	76	36	46	49	67
11	76	24	52	37	66	50	76
12	67	25	42	38	88		
13	64	26	43	39	48		

Table 14. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 3

No.	Length	No.	Length	No.	Length	No.	Length
1	67	14	45	27	76	40	66
2	85	15	66	28	64	41	46
3	76	16	46	29	67	42	45
4	48	17	46	30	45	43	46
5	48	18	48	31	85	44	52
6	52	19	88	32	68	45	84
7	76	20	52	33	84	46	42
8	48	21	64	34	56	47	76
9	42	22	67	35	67	48	64
10	68	23	76	36	64	49	76
11	43	24	56	37	76	50	85
12	68	25	84	38	48		
13	85	26	52	39	88		

Table 15. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 4

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	64	27	64	40	76
2	76	15	76	28	76	41	85
3	64	16	42	29	48	42	43
4	67	17	84	30	84	43	88
5	45	18	52	31	66	44	76
6	85	19	46	32	46	45	67
7	68	20	45	33	45	46	88
8	84	21	46	34	46	47	52
9	56	22	66	35	56	48	64
10	67	23	88	36	84	49	67
11	65	24	48	37	42	50	42
12	85	25	76	38	76		
13	76	26	67	39	64		

Table 16. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 5

No.	Length	No.	Length	No.	Length	No.	Length
1	67	14	64	27	64	40	64
2	64	15	76	28	88	41	88
3	76	16	85	29	43	42	67
4	88	17	43	30	67	43	43
5	48	18	42	31	76	44	42
6	66	19	67	32	66	45	85
7	46	20	64	33	64	46	64
8	46	21	52	34	48	47	76
9	45	22	88	35	52	48	76
10	52	23	67	36	88	49	42
11	84	24	76	37	76	50	84
12	42	25	88	38	67		
13	76	26	76	39	52		

Table 17. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 6

No.	Length	No.	Length	No.	Length	No.	Length
1	42	14	43	27	88	40	66
2	67	15	64	28	67	41	48
3	64	16	67	29	76	42	43
4	52	17	84	30	88	43	42
5	76	18	52	31	48	44	84
6	43	19	76	32	52	45	43
7	84	20	48	33	76	46	76
8	42	21	88	34	84	47	52
9	43	22	76	35	67	48	64
10	48	23	67	36	64	49	67
11	64	24	88	37	43	50	42
12	76	25	52	38	88		
13	88	26	52	39	76		

Table 18. Original conidial length measurements of isolates of C. beticola from B. vulgaris—Isolate 7

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	52	27	67	40	52
2	88	15	64	28	64	41	48
3	43	16	48	29	43	42	88
4	64	17	43	30	88	43	52
5	67	18	42	31	76	44	64
6	84	19	84	32	64	45	67
7	76	20	43	33	48	46	42
8	52	21	76	34	43	47	76
9	48	22	52	35	42	48	67
10	88	23	64	36	84	49	88
11	76	24	67	37	43	50	52
12	67	25	42	38	76		
13	88	26	84	39	76		

Table 19. Original conidial length measurements of isolates of C. beticola from B. vulgaris—Isolate 8

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	46	27	76	40	67
2	67	15	66	28	48	41	57
3	45	16	46	29	88	42	56
4	85	17	45	30	66	43	85
5	68	18	52	31	46	44	84
6	84	19	46	32	45	45	67
7	56	20	84	33	46	46	68
8	57	21	42	34	52	47	45
9	67	22	76	35	84	48	85
10	64	23	64	36	42	49	76
11	76	24	76	37	76	50	43
12	48	25	85	38	64		
13	88	26	64	39	76		

Table 20. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 9

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	76	27	76	40	76
2	88	15	84	28	67	41	67
3	67	16	42	29	88	42	48
4	76	17	43	30	43	43	76
5	42	18	64	31	50	44	52
6	67	19	48	32	76	45	76
7	64	20	76	33	64	46	84
8	52	21	80	34	67	47	64
9	48	22	43	35	43	48	67
10	88	23	67	36	48	49	43
11	52	24	84	37	64	50	88
12	76	25	64	38	88		
13	43	26	42	39	52		

Table 21. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 10

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	88	27	42	40	88
2	88	15	64	28	76	41	52
3	67	16	48	29	75	42	48
4	76	17	43	30	64	43	64
5	88	18	42	31	84	44	66
6	48	19	84	32	42	45	75
7	76	20	42	33	43	46	65
8	52	21	76	34	67	47	43
9	84	22	52	35	88	48	88
10	67	23	64	36	64	49	64
11	64	24	67	37	52	50	76
12	43	25	42	38	67		
13	76	26	84	39	76		

Table 22. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 11

No.	Length	No.	Length	No.	Length	No.	Length
1	42	14	67	27	76	40	64
2	52	15	76	28	64	41	67
3	76	16	84	29	76	42	56
4	43	17	54	30	42	43	84
5	89	18	48	31	84	44	68
6	42	19	88	32	52	45	85
7	43	20	76	33	46	46	45
8	48	21	67	34	45	47	67
9	64	22	88	35	46	48	64
10	76	23	52	36	66	49	76
11	88	24	64	37	88	50	52
12	43	25	67	38	48		
13	64	26	85	39	76		

Table 23. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 12

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	76	27	76	40	84
2	76	15	85	28	85	41	56
3	48	16	65	29	88	42	46
4	88	17	67	30	76	43	45
5	66	18	56	31	67	44	46
6	46	19	84	32	88	45	66
7	45	20	68	33	52	46	84
8	46	21	85	34	64	47	48
9	52	22	45	35	67	48	76
10	84	23	67	36	42	49	64
11	42	24	64	37	64	50	67
12	76	25	76	38	76		
13	64	26	43	39	42		

Table 24. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 13

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	52	27	64	40	67
2	64	15	64	28	43	41	42
3	88	16	88	29	76	42	84
4	43	17	67	30	88	43	52
5	65	18	43	31	64	44	76
6	75	19	42	32	48	45	48
7	66	20	84	33	43	46	88
8	64	21	64	34	42	47	76
9	48	22	75	35	84	48	67
10	52	23	76	36	42	49	88
11	88	24	42	37	76	50	52
12	76	25	84	38	52		
13	67	26	67	39	64		

Table 25. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 14

No.	Length	No.	Length	No.	Length	No.	Length
1	67	14	56	27	42	40	65
2	42	15	46	28	89	41	67
3	64	16	45	29	52	42	56
4	52	17	46	30	46	43	84
5	88	18	66	31	45	44	68
6	67	19	84	32	46	45	85
7	76	20	48	33	66	46	45
8	88	21	76	34	88	47	67
9	43	22	64	35	48	48	64
10	85	23	67	36	76	49	76
11	76	24	64	37	64	50	52
12	42	25	76	38	76		
13	84	26	76	39	85		

Table 26. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 15

No.	Length	No.	Length	No.	Length	No.	Length
1	42	14	76	27	88	40	84
2	84	15	88	28	67	41	52
3	76	16	52	29	88	42	45
4	64	17	48	30	52	43	46
5	76	18	69	31	64	44	46
6	85	19	66	32	42	45	66
7	42	20	76	33	67	46	48
8	43	21	67	34	43	47	88
9	47	22	43	35	85	48	76
10	88	23	88	36	76	49	64
11	64	24	64	37	64	50	67
12	52	25	76	38	76		
13	67	26	76	39	42		

Table 27. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 16

No.	Length	No.	Length	No.	Length	No.	Length
1	64	14	76	27	80	40	67
2	88	15	88	28	64	41	64
3	67	16	52	29	76	42	76
4	43	17	48	30	85	43	88
5	42	18	64	31	43	44	45
6	85	19	66	32	42	45	66
7	64	20	76	33	67	46	46
8	76	21	67	34	64	47	45
9	76	22	43	35	52	48	42
10	42	23	88	36	88	49	52
11	84	24	64	37	67	50	84
12	52	25	76	38	76		
13	67	26	42	39	88		

Table 28. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 17

No.	Length	No.	Length	No.	Length	No.	Length
1	85	14	42	27	42	40	65
2	43	15	84	28	84	41	65
3	88	16	56	29	52	42	56
4	76	17	46	30	46	43	84
5	67	18	45	31	45	44	68
6	88	19	46	32	45	45	85
7	52	20	65	33	66	46	45
8	64	21	84	34	88	47	67
9	67	22	48	35	48	48	64
10	42	23	75	36	76	49	75
11	76	24	64	37	64	50	52
12	64	25	67	38	76		
13	76	26	76	39	85		

Table 29. Original conidial length measurements of isolates of *C. beticola* from *B. vulgaris*—Isolate 18

No.	Length	No.	Length	No.	Length	No.	Length
1	46	14	48	27	57	40	42
2	45	15	76	28	56	41	84
3	52	16	64	29	85	42	52
4	45	17	65	30	84	43	46
5	85	18	57	31	67	44	45
6	42	19	56	32	68	45	46
7	76	20	85	33	45	46	65
8	65	21	68	34	85	47	88
9	75	22	85	35	76	48	48
10	85	23	45	36	43	49	75
11	66	24	68	37	76	50	66
12	46	25	76	38	64		
13	88	26	67	39	76		

Table 30. Original conidial length measurements of isolates of C. beticola from B. vulgaris—Isolate 19

No.	Length	No.	Length	No.	Length	No.	Length
1	64	14	43	27	52	40	88
2	48	15	64	28	48	41	67
3	43	16	67	29	64	42	43
4	42	17	84	30	66	43	42
5	85	18	52	31	65	44	84
6	42	19	76	32	43	45	64
7	76	20	48	33	88	46	75
8	52	21	88	34	64	47	76
9	64	22	75	35	76	48	42
10	67	23	67	36	76	49	85
11	42	24	88	37	65	50	65
12	88	25	52	38	52		
13	76	26	88	39	64		

Table 31. Original conidial length measurements of isolates of C. beticola from B. vulgaris—Isolate 20

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	84	27	48	40	64
2	67	15	88	28	43	41	67
3	52	16	52	29	42	42	84
4	64	17	48	30	84	43	52
5	88	18	64	31	42	44	76
6	65	19	66	32	75	45	48
7	43	20	75	33	52	46	88
8	42	21	65	34	65	47	76
9	84	22	43	35	67	48	67
10	64	23	88	36	42	49	88
11	75	24	64	37	88	50	52
12	76	25	76	38	76		
13	45	26	64	39	43		

Table 32. Original conidial length measurements of C. beticola from P. pennsylvanicum—Trial 1

No.	Length	No.	Length	No.	Length	No.	Length
1	85	14	76	27	76	40	84
2	76	15	64	28	67	41	56
3	64	16	67	29	88	42	46
4	76	17	56	30	52	43	45
5	42	18	84	31	64	44	46
6	84	19	68	32	67	45	66
7	52	20	85	33	42	46	84
8	46	21	45	34	43	47	48
9	45	22	67	35	85	48	76
10	46	23	64	36	76	49	64
11	66	24	76	37	64	50	67
12	88	25	52	38	76		
13	48	26	88	39	42		

Table 33. Original conidial length measurements of C. beticola from P. pennsylvanicum—Trial 2

No.	Length	No.	Length	No.	Length	No.	Length
1	75	14	50	27	76	40	65
2	64	15	42	28	66	41	64
3	46	16	67	29	76	42	42
4	84	17	45	30	88	43	75
5	75	18	66	31	44	44	86
6	76	19	46	32	85	45	52
7	48	20	64	33	67	46	76
8	65	21	66	34	46	47	84
9	88	22	42	35	45	48	48
10	67	23	48	36	76	49	46
11	46	24	64	37	85	50	45
12	84	25	56	38	75		
13	56	26	65	39	67		

Table 34. Original conidial length measurements of C. beticola from P. pennsylvanicum—Trial 3

No.	Length	No.	Length	No.	Length	No.	Length
1	64	14	64	27	76	40	65
2	76	15	68	28	46	41	64
3	65	16	85	29	75	42	48
4	56	17	66	30	67	43	76
5	88	18	84	31	64	44	38
6	48	19	45	32	88	45	45
7	56	20	46	33	84	46	75
8	84	21	42	34	52	47	85
9	65	22	88	35	42	48	75
10	76	23	52	36	65	49	67
11	42	24	45	37	45	50	85
12	75	25	46	38	67		
13	67	26	52	39	88		

Table 35. Original conidial length measurements of C. beticola from P. pennsylvanicum—Trial 4

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	67	27	42	40	48
2	65	15	85	28	85	41	66
3	56	16	42	29	46	42	85
4	88	17	64	30	76	43	42
5	45	18	75	31	52	44	56
6	84	19	65	32	45	45	68
7	48	20	88	33	84	46	53
8	76	21	75	34	76	47	45
9	45	22	67	35	65	48	65
10	66	23	84	36	67	49	76
11	52	24	43	37	85	50	67
12	46	25	65	38	76		
13	64	26	46	39	84		

Table 36. Original conidial length measurements of C. beticola from P. pennsylvanicum—Trial 5

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	42	27	84	40	62
2	52	15	65	28	76	41	44
3	46	16	84	29	88	42	67
4	45	17	48	30	67	43	46
5	65	18	84	31	56	44	66
6	66	19	64	32	76	45	43
7	85	20	52	33	65	46	45
8	45	21	76	34	48	47	84
9	76	22	65	35	45	48	88
10	65	23	56	36	85	49	45
11	76	24	67	37	76	50	52
12	88	25	42	38	88		
13	76	26	65	39	67		

Table 37. Original conidial length measurements of isolates of C. beticola from P. aviculare—Trial 1

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	78	27	44	40	64
2	64	15	66	28	67	41	43
3	76	16	46	29	64	42	88
4	67	17	45	30	52	43	76
5	45	18	46	31	88	44	64
6	85	19	52	32	67	45	48
7	68	20	84	33	76	46	43
8	84	21	42	34	88	47	42
9	56	22	76	35	48	48	84
10	67	23	64	36	52	49	43
11	64	24	76	37	84	50	76
12	76	25	85	38	76		
13	48	26	43	39	67		

Table 38. Original conidial length measurements of isolates of *C. beticola* from *P. aviculare*—Trial 2

No.	Length	No.	Length	No.	Length	No.	Length
1	67	14	54	27	46	40	64
2	66	15	64	28	64	41	56
3	65	16	76	29	88	42	48
4	46	17	48	30	43	43	67
5	88	18	67	31	48	44	54
6	85	19	88	32	84	45	42
7	75	20	43	33	80	46	67
8	76	21	52	34	52	47	84
9	65	22	45	35	68	48	67
10	43	23	43	36	84	49	75
11	76	24	76	37	45	50	85
12	40	25	84	38	76		
13	76	26	64	39	42		

Table 39. Original conidial length measurements of isolates of *C. beticola* from *P. aviculare*—Trial 3

No.	Length	No.	Length	No.	Length	No.	Length
1	46	14	46	27	76	40	43
2	52	15	84	28	64	41	76
3	76	16	66	29	88	42	42
4	65	17	84	30	52	43	65
5	88	18	67	31	68	44	76
6	64	19	52	32	48	45	67
7	67	20	88	33	84	46	84
8	45	21	77	34	82	47	46
9	42	22	65	35	65	48	86
10	76	23	67	36	43	49	55
11	52	24	42	37	48	50	66
12	48	25	85	38	76		
13	76	26	43	39	54		

Table 40. Original conidial length measurements of isolates of C. beticola from P. aviculare—Trial 4

No.	Length	No.	Length	No.	Length	No.	Length
1	50	14	82	27	64	40	43
2	76	15	43	28	75	41	46
3	52	16	45	29	74	42	83
4	88	17	88	30	63	43	64
5	62	18	43	31	88	44	82
6	74	19	65	32	46	45	66
7	52	20	42	33	74	46	88
8	62	21	75	34	67	47	74
9	82	22	46	35	42	48	43
10	46	23	48	36	54	49	65
11	52	24	64	37	52	50	42
12	64	25	83	38	74		
13	65	26	82	39	88		

Table 41. Original conidial length measurements of isolates of C. beticola from P. aviculare—Trial 5

No.	Length	No.	Length	No.	Length	No.	Length
1	64	14	88	27	46	40	42
2	52	15	67	28	84	41	76
3	88	16	65	29	68	42	65
4	43	17	84	30	88	43	76
5	76	18	65	31	67	44	46
6	64	19	44	32	42	45	75
7	65	20	67	33	85	46	82
8	42	21	48	34	42	47	45
9	64	22	46	35	85	48	42
10	76	23	76	36	45	49	52
11	48	24	67	37	52	50	85
12	76	25	43	38	76		
13	52	26	55	39	84		

Table 42. Original conidial length measurements of C. beticola from P. persicaria—Trial 1

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	76	27	42	40	88
2	88	15	64	28	76	41	48
3	67	16	48	29	64	42	52
4	76	17	43	30	76	43	64
5	80	18	42	31	85	44	66
6	48	19	84	32	48	45	76
7	52	20	43	33	45	46	67
8	76	21	76	34	67	47	43
9	84	22	52	35	64	48	88
10	67	23	64	36	88	49	64
11	64	24	67	37	52	50	76
12	43	25	42	38	67		
13	88	26	84	39	76		

Table 43. Original conidial length measurements of C. beticola from P. persicaria—Trial 2

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	52	27	42	40	88
2	88	15	88	28	67	41	45
3	64	16	52	29	52	42	85
4	67	17	84	30	88	43	65
5	48	18	76	31	64	44	42
6	76	19	51	32	42	45	88
7	42	20	75	33	75	46	76
8	67	21	88	34	65	47	84
9	44	22	52	35	43	48	43
10	76	23	48	36	43	49	64
11	64	24	66	37	88	50	66
12	85	25	52	38	67		
13	67	26	76	39	85		

Table 44. Original conidial length measurements of C. beticola from P. persicaria—Trial 3

No.	Length	No.	Length	No.	Length	No.	Length
1	52	14	48	27	66	40	53
2	88	15	84	28	43	41	42
3	85	16	42	29	65	42	76
4	76	17	76	30	84	43	67
5	64	18	43	31	46	44	65
6	88	19	64	32	84	45	43
7	64	20	66	33	45	46	42
8	66	21	84	34	75	47	64
9	76	22	76	35	43	48	76
10	52	23	67	36	65	49	48
11	65	24	76	37	88	50	53
12	88	25	85	38	67		
13	80	26	48	39	52		

Table 45. Original conidial length measurements of C. beticola from P. persicaria—Trial 4

No.	Length	No.	Length	No.	Length	No.	Length
1	84	14	84	27	76	40	76
2	43	15	67	28	67	41	88
3	76	16	85	29	65	42	67
4	88	17	88	30	42	43	77
5	45	18	65	31	64	44	42
6	76	19	67	32	43	45	88
7	64	20	42	33	76	46	44
8	42	21	66	34	64	47	88
9	76	22	52	35	43	48	54
10	64	23	64	36	88	49	75
11	88	24	84	37	52	50	54
12	48	25	48	38	64		
13	76	26	43	39	65		

Table 46. Original conidial length measurements of C. beticola from P. persicaria—Trial 5

No.	Length	No.	Length	No.	Length	No.	Length
1	76	14	42	27	66	40	85
2	64	15	76	28	88	41	64
3	54	16	52	29	67	42	88
4	52	17	43	30	64	43	45
5	67	18	65	31	48	44	69
6	84	19	84	32	42	45	75
7	46	20	66	33	76	46	42
8	67	21	48	34	43	47	76
9	88	22	76	35	88	48	75
10	64	23	67	36	84	49	43
11	48	24	42	37	54	50	52
12	43	25	75	38	67		
13	64	26	85	39	75		

Table 47. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 1

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	19	30	26	15	30
2	30	18	27	16	15
3	28	18	28	20	15
4	20	19	29	12	30
5	28	12	30	30	15
6	16	16	31	16	19
7	30	28	32	18	18
8	18	17	33	18	15
9	19	30	34	19	18
10	28	15	35	20	30
11	15	18	36	17	16
12	20	14	37	28	20
13	12	19	38	18	12
14	30	16	39	15	19
15	28	17	40	30	28
16	28	15	41	13	30
17	18	16	42	19	16
18	18	14	43	14	15
19	20	12	44	16	15
20	15	20	45	30	30
21	15	16	46	12	15
22	28	28	47	17	14
23	18	20	48	18	30
24	19	15	49	16	12
25	15	28	50	15	19

Table 48. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 2

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	15	15	26	12	28
2	15	18	27	16	18
3	18	20	28	20	19
4	20	30	29	14	18
5	16	18	30	15	30
6	18	18	31	30	18
7	20	15	32	18	15
8	18	16	33	17	12
9	18	20	34	16	16
10	28	19	35	12	19
11	30	19	36	30	28
12	19	18	37	12	17
13	28	16	38	19	18
14	20	15	39	14	20
15	30	20	40	30	30
16	28	18	41	15	18
17	15	18	42	18	18
18	19	30	43	17	16
19	18	16	44	30	17
20	16	19	45	19	19
21	30	16	46	20	15
22	28	15	47	30	28
23	28	18	48	18	30
24	19	20	49	18	28
25	20	12	50	16	18

Table 49. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 3

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	16	28	26	16	20
2	12	20	27	15	18
3	18	15	28	15	20
4	30	12	29	18	18
5	20	28	30	20	15
6	19	16	31	30	18
7	18	15	32	18	18
8	15	28	33	20	18
9	30	29	34	12	20
10	19	14	35	30	30
11	16	16	36	20	19
12	17	20	37	30	30
13	15	16	38	12	15
14	20	30	39	30	17
15	28	12	40	18	15
16	30	20	41	30	29
17	19	30	42	16	20
18	15	20	43	28	16
19	12	18	44	19	30
20	30	30	45	16	12
21	20	20	46	20	18
22	28	28	47	30	18
23	28	18	48	18	19
24	18	29	49	14	19
25	18	30	50	29	16

Table 50. Original conidial length measurements of isolates of *C. avicularis* from *P. aviculare* of Monona County—Isolate 4

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	20	20	26	17	20
2	18	12	27	30	30
3	18	30	28	20	18
4	15	28	29	18	12
5	16	19	30	12	16
6	28	28	31	20	19
7	30	20	32	30	16
8	15	30	33	19	13
9	16	15	34	16	18
10	12	18	35	25	16
11	19	19	36	28	15
12	14	30	37	28	18
13	30	28	38	19	22
14	17	12	39	18	15
15	18	28	40	18	28
16	16	18	41	16	30
17	12	16	42	30	17
18	18	18	43	15	30
19	18	25	44	30	14
20	19	16	45	28	18
21	30	19	46	13	19
22	20	18	47	28	18
23	28	22	48	30	17
24	15	30	49	18	12
25	12	28	50	19	15

Table 51. Original conidial length measurements of isolates of *C. avicularis* from *P. aviculare* of Monona County—Isolate 5

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	18	14	26	22	30
2	15	30	27	18	15
3	19	18	28	28	18
4	17	12	29	18	28
5	18	20	30	30	18
6	18	22	31	20	18
7	12	16	32	19	28
8	28	19	33	28	28
9	16	30	34	18	30
10	19	20	35	15	16
11	20	19	36	19	19
12	30	19	37	28	16
13	14	19	38	19	30
14	19	28	39	20	19
15	30	30	40	30	20
16	16	16	41	18	16
17	19	12	42	30	17
18	12	20	43	12	19
19	18	18	44	16	18
20	20	12	45	15	15
21	30	15	46	15	18
22	16	30	47	30	18
23	28	15	48	12	12
24	16	18	49	18	28
25	28	20	50	20	19

Table 52. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 6

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	18	19	26	12	19
2	28	30	27	18	18
3	18	16	28	16	12
4	17	28	29	28	19
5	15	30	30	30	18
6	17	15	31	16	16
7	20	18	32	18	16
8	19	19	33	12	15
9	28	16	34	16	20
10	30	30	35	20	30
11	14	15	36	18	28
12	16	28	37	20	18
13	12	12	38	28	13
14	15	18	39	28	20
15	20	15	40	22	17
16	30	14	41	18	30
17	19	12	42	16	18
18	16	20	43	15	20
19	20	30	44	19	15
20	20	16	45	30	30
21	19	18	46	15	30
22	28	30	47	12	17
23	18	20	48	15	28
24	30	28	49	30	22
25	16	16	50	28	20

Table 53. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 7

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	20	28	26	19	19
2	16	22	27	16	30
3	19	28	28	16	17
4	16	17	29	28	16
5	14	30	30	30	26
6	16	15	31	12	18
7	12	16	32	20	20
8	15	18	33	15	30
9	30	19	34	28	12
10	30	28	35	30	21
11	19	16	36	18	28
12	18	12	37	20	20
13	19	20	38	16	28
14	20	16	39	17	15
15	30	30	40	19	20
16	12	18	41	28	30
17	15	20	42	30	14
18	28	19	43	28	19
19	18	30	44	18	16
20	17	18	45	12	19
21	19	15	46	30	30
22	18	18	47	18	19
23	30	12	48	19	12
24	20	19	49	20	16
25	16	12	50	18	18

Table 54. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 8

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	18	18	26	16	18
2	16	20	27	15	22
3	19	30	28	18	30
4	12	20	29	28	14
5	15	15	30	30	18
6	30	18	31	20	12
7	15	16	32	28	17
8	28	28	33	20	18
9	15	18	34	16	30
10	30	12	35	12	15
11	18	20	36	28	20
12	14	18	37	16	15
13	19	30	38	28	28
14	18	16	39	30	19
15	17	20	40	19	15
16	18	17	41	22	30
17	18	30	42	17	16
18	30	30	43	19	28
19	20	19	44	30	18
20	18	28	45	20	12
21	20	19	46	16	16
22	30	12	47	18	20
23	20	28	48	12	19
24	12	18	49	19	28
25	18	19	50	28	16

Table 55. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Monona County—Isolate 9

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	20	20	26	15	17
2	18	16	27	18	19
3	28	30	28	20	30
4	14	22	29	30	20
5	19	28	30	16	20
6	30	19	31	20	19
7	20	30	32	12	16
8	17	18	33	18	28
9	19	19	34	22	16
10	18	16	35	30	30
11	30	28	36	19	19
12	30	20	37	28	18
13	28	18	38	20	19
14	16	20	39	16	12
15	15	12	40	18	19
16	17	14	41	30	30
17	12	18	42	28	17
18	19	15	43	19	16
19	18	18	44	15	30
20	19	28	45	16	16
21	12	30	46	13	18
22	28	15	47	16	12
23	20	16	48	18	30
24	30	12	49	16	28
25	16	18	50	28	16

Table 56. Original conidial length measurements of isolates of *C. avicularis* from *P. aviculare* of Monona County—Isolate 10

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	16	18	26	12	18
2	18	16	27	20	12
3	15	15	28	16	16
4	12	18	29	15	20
5	20	16	30	18	30
6	19	30	31	15	20
7	28	16	32	30	18
8	19	12	33	18	16
9	20	20	34	17	30
10	30	15	35	18	28
11	19	12	36	30	18
12	18	20	37	18	20
13	28	18	38	12	16
14	28	20	39	17	18
15	28	17	40	18	12
16	12	20	41	20	28
17	16	19	42	28	28
18	20	30	43	15	30
19	30	28	44	30	17
20	17	17	45	20	15
21	18	19	46	15	28
22	20	18	47	20	30
23	16	20	48	30	21
24	20	20	49	18	18
25	30	30	50	16	19

Table 57. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Story County—Isolate 1

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	20	19	26	30	17
2	12	18	27	20	28
3	16	12	28	14	16
4	28	18	29	18	18
5	30	20	30	16	12
6	18	19	31	28	15
7	16	16	32	12	18
8	18	30	33	20	16
9	16	18	34	18	18
10	12	28	35	15	16
11	18	16	36	18	30
12	19	15	37	16	17
13	28	28	38	30	18
14	17	15	39	16	12
15	20	18	40	12	19
16	30	28	41	15	21
17	12	30	42	12	15
18	15	12	43	18	18
19	20	20	44	30	14
20	18	28	45	15	18
21	28	16	46	18	28
22	19	30	47	30	20
23	28	16	48	16	30
24	20	12	49	18	20
25	18	20	50	19	13

Table 58. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Story County—Isolate 2

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	15	16	26	12	20
2	18	20	27	18	16
3	15	28	28	16	18
4	12	18	29	20	12
5	20	12	30	30	15
6	16	20	31	19	20
7	18	18	32	28	18
8	28	15	33	30	19
9	20	16	34	18	28
10	16	15	35	20	30
11	18	28	36	18	28
12	18	30	37	28	19
13	19	20	38	16	14
14	15	16	39	20	16
15	18	18	40	12	20
16	18	19	41	15	15
17	16	15	42	18	18
18	20	18	43	14	17
19	30	18	44	19	30
20	28	16	45	18	28
21	18	20	46	17	19
22	16	18	47	30	20
23	18	28	48	28	28
24	20	16	49	19	18
25	15	30	50	20	20

Table 59. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Story County—Isolate 3

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	18	12	26	20	12
2	18	18	27	16	19
3	16	16	28	30	17
4	18	18	29	28	28
5	19	16	30	12	18
6	18	20	31	18	28
7	20	17	32	18	20
8	18	18	33	16	19
9	20	20	34	18	18
10	15	16	35	19	30
11	15	20	36	30	15
12	18	18	37	28	18
13	12	19	38	17	16
14	30	18	39	20	20
15	16	19	40	19	18
16	12	30	41	18	28
17	28	18	42	14	12
18	16	14	43	12	28
19	18	20	44	15	16
20	15	18	45	20	28
21	18	20	46	28	30
22	20	15	47	20	16
23	30	28	48	28	12
24	28	20	49	20	30
25	16	20	50	19	15

Table 60. Original conidial length measurements of isolates of C. avicularis from P. aviculare of Story County—Isolate 4

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	20	15	26	18	19
2	28	28	27	19	28
3	17	15	28	15	18
4	30	12	29	18	15
5	19	30	30	15	18
6	18	20	31	18	12
7	16	16	32	28	30
8	18	18	33	20	20
9	18	28	34	19	28
10	12	18	35	15	20
11	28	20	36	18	15
12	16	19	37	12	18
13	20	18	38	30	19
14	15	18	39	28	17
15	18	18	40	18	18
16	20	18	41	20	30
17	19	16	42	16	28
18	28	20	43	18	22
19	20	25	44	18	16
20	28	16	45	18	30
21	30	12	46	16	19
22	20	15	47	16	20
23	12	19	48	20	13
24	15	14	49	12	18
25	14	20	50	25	16

Table 61. Original conidial length measurements of isolates of *C. avicularis* from *P. aviculare* of Story County—Isolate 5

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	19	18	26	16	16
2	30	16	27	12	20
3	18	12	28	20	12
4	14	18	29	30	15
5	15	30	30	18	18
6	12	16	31	12	30
7	20	12	32	18	18
8	28	18	33	30	30
9	20	28	34	16	28
10	30	30	35	18	20
11	28	16	36	19	18
12	19	18	37	18	30
13	20	19	38	20	15
14	18	16	39	16	17
15	15	18	40	20	20
16	20	28	41	30	15
17	28	12	42	15	20
18	17	18	43	16	19
19	19	20	44	18	20
20	18	18	45	16	14
21	16	19	46	30	16
22	18	28	47	16	30
23	18	15	48	18	18
24	13	16	49	15	20
25	28	18	50	18	28

Table 62. Original conidial length measurements of isolates of *C. persicariae* from *P. persicaria* of Monona County—Isolate 1

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	22	26	26	25	22
2	66	30	27	28	25
3	30	25	28	66	28
4	28	65	29	26	45
5	66	25	30	45	66
6	25	22	31	22	25
7	22	30	32	25	35
8	35	28	33	28	22
9	30	45	34	60	30
10	22	30	35	26	28
11	28	66	36	28	25
12	30	28	37	30	66
13	45	22	38	66	25
14	25	28	39	25	28
15	30	25	40	28	28
16	23	35	41	45	25
17	28	66	42	30	28
18	66	30	43	25	35
19	45	35	44	25	60
20	22	28	45	28	30
21	25	28	46	22	26
22	35	22	47	28	28
23	28	45	48	35	66
24	30	22	49	28	28
25	65	45	50	28	22

Table 63. Original conidial length measurements of isolates of *C. persicariae* from *P. persicaria* of Monona County—Isolate 2

No.	From host length	From *B. vulgaris* length	No.	From host Length	From *B. vulgaris* length
1	45	30	26	22	35
2	22	45	27	28	30
3	30	22	28	35	66
4	28	45	29	25	25
5	25	30	30	28	28
6	66	66	31	28	32
7	45	35	32	35	66
8	22	28	33	22	25
9	45	22	34	28	28
10	30	28	35	66	26
11	66	28	36	28	35
12	28	35	37	25	45
13	22	66	38	35	30
14	35	35	39	66	22
15	30	25	40	25	60
16	25	26	41	28	45
17	28	28	42	26	22
18	60	30	43	60	30
19	30	60	44	28	28
20	45	28	45	30	25
21	26	66	46	25	66
22	28	30	47	45	35
23	25	25	48	28	45
24	30	28	49	30	22
25	66	22	50	66	26

Table 64. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 3

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	25	22	26	45	25
2	28	28	27	28	25
3	66	28	28	28	26
4	30	26	29	22	28
5	25	30	30	66	66
6	22	66	31	30	30
7	45	45	32	28	22
8	30	26	33	25	30
9	28	28	34	45	66
10	66	22	35	66	30
11	45	25	36	30	45
12	22	35	37	28	35
13	66	22	38	60	22
14	25	28	39	26	25
15	28	25	40	28	30
16	30	28	41	66	60
17	45	25	42	25	30
18	22	22	43	22	28
19	25	35	44	35	22
20	35	46	45	25	66
21	28	66	46	22	46
22	30	28	47	66	25
23	25	66	48	28	26
24	28	28	49	35	28
25	26	45	50	22	66

Table 65. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 4

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	22	22	26	22	25
2	66	30	27	30	30
3	30	45	28	28	22
4	25	28	29	22	28
5	28	66	30	66	28
6	26	45	31	45	30
7	45	30	32	30	22
8	66	35	33	22	66
9	60	28	34	25	28
10	30	25	35	66	36
11	25	60	36	28	22
12	22	45	37	60	28
13	28	25	38	22	65
14	30	45	39	28	25
15	35	28	40	66	26
16	28	22	41	26	66
17	30	25	42	25	26
18	22	26	43	66	66
19	45	66	44	35	25
20	45	30	45	25	66
21	66	22	46	28	28
22	25	30	47	22	22
23	28	28	48	28	30
24	30	22	49	35	35
25	45	45	50	25	66

Table 66. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 5

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	30	28	26	45	66
2	28	66	27	65	36
3	22	30	28	22	25
4	28	26	29	45	28
5	60	45	30	66	28
6	66	25	31	30	45
7	26	28	32	28	22
8	35	28	33	25	30
9	25	35	34	45	26
10	28	26	35	35	66
11	22	28	36	30	22
12	35	65	37	66	26
13	28	22	38	25	30
14	28	28	39	28	66
15	45	35	40	22	28
16	66	30	41	26	30
17	30	28	42	28	66
18	60	45	43	26	26
19	22	66	44	28	60
20	66	35	45	66	22
21	30	65	46	35	35
22	35	45	47	25	22
23	66	28	48	28	66
24	28	22	49	25	25
25	23	28	50	28	28

Table 67. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 6

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	30	45	26	22	66
2	22	66	27	30	35
3	35	28	28	45	28
4	66	30	29	66	45
5	45	22	30	30	66
6	26	28	31	28	26
7	28	45	32	28	35
8	35	28	33	60	30
9	36	60	34	26	66
10	28	30	35	66	28
11	22	22	36	35	36
12	28	28	37	26	22
13	30	35	38	28	30
14	66	66	39	35	26
15	28	30	40	45	26
16	45	26	41	66	28
17	26	28	42	22	22
18	25	26	43	35	36
19	45	22	44	30	45
20	28	35	45	28	66
21	30	26	46	22	28
22	28	45	47	28	28
23	66	35	48	30	45
24	35	28	49	45	30
25	25	30	50	60	66

Table 68. Original conidial length measurements of isolates of *C. persicariae* from *P. persicaria* of Monona County—Isolate 7

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	25	28	26	45	30
2	30	36	27	28	28
3	28	45	28	30	36
4	22	28	29	28	28
5	36	22	30	66	36
6	25	46	31	28	28
7	28	30	32	22	22
8	45	25	33	26	65
9	36	28	34	30	45
10	22	22	35	28	28
11	66	28	36	30	26
12	30	26	37	66	22
13	28	66	38	22	60
14	45	36	39	36	30
15	28	25	40	28	28
16	66	60	41	60	66
17	25	26	42	66	26
18	28	66	43	28	46
19	46	30	44	60	66
20	26	23	45	26	28
21	28	30	46	25	26
22	22	26	47	66	30
23	45	28	48	25	46
24	30	25	49	30	28
25	25	66	50	36	30

Table 69. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 8

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	30	28	26	30	28
2	26	25	27	28	46
3	45	22	28	45	28
4	28	28	29	28	36
5	25	26	30	23	66
6	28	45	31	30	35
7	22	66	32	60	60
8	25	25	33	66	22
9	35	28	34	26	30
10	25	25	35	28	45
11	36	22	36	66	26
12	66	28	37	26	30
13	22	66	38	60	28
14	26	26	39	28	66
15	28	28	40	66	25
16	25	35	41	30	60
17	28	36	42	22	22
18	45	25	43	35	28
19	30	65	44	30	66
20	28	30	45	25	26
21	35	28	46	28	28
22	28	46	47	66	30
23	22	32	48	45	28
24	28	28	49	46	45
25	66	23	50	32	30

Table 70. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 9

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	30	26	26	26	30
2	66	45	27	22	46
3	25	60	28	28	66
4	30	22	29	60	28
5	36	28	30	22	26
6	30	66	31	28	25
7	28	28	32	35	28
8	30	28	33	46	22
9	28	26	34	60	66
10	66	46	35	28	30
11	28	30	36	66	35
12	25	36	37	30	28
13	46	66	38	25	30
14	25	28	39	22	22
15	36	22	40	28	28
16	46	25	41	66	66
17	28	66	42	26	36
18	66	25	43	25	28
19	28	30	44	35	36
20	22	26	45	28	60
21	45	28	46	22	46
22	30	46	47	25	30
23	26	25	48	35	26
24	60	22	49	28	28
25	45	28	50	28	30

Table 71. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Monona County—Isolate 10

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	28	22	26	25	46
2	25	30	27	30	30
3	26	28	28	35	35
4	35	30	29	66	66
5	28	28	30	28	22
6	26	36	31	45	30
7	66	45	32	60	25
8	28	22	33	30	28
9	28	66	34	22	66
10	28	25	35	46	60
11	22	45	36	45	26
12	26	60	37	46	28
13	66	26	38	66	26
14	60	28	39	25	28
15	22	30	40	26	62
16	30	28	41	30	45
17	45	30	42	28	28
18	28	66	43	30	35
19	30	26	44	28	26
20	35	35	45	66	28
21	66	26	46	35	66
22	25	28	47	26	26
23	22	46	48	22	25
24	28	22	49	28	22
25	30	30	50	30	28

Table 72. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Story County—Isolate 1

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	22	22	26	35	28
2	25	28	27	28	35
3	30	25	28	25	28
4	25	28	29	28	28
5	22	66	30	66	66
6	28	26	31	66	60
7	45	28	32	28	25
8	30	22	33	35	26
9	22	30	34	22	30
10	22	36	35	25	28
11	66	26	36	28	60
12	45	28	37	26	45
13	25	28	38	25	30
14	28	22	39	28	22
15	26	22	40	30	25
16	35	66	41	22	28
17	30	45	42	25	26
18	22	22	43	45	25
19	25	30	44	65	28
20	28	45	45	30	25
21	26	28	46	28	35
22	66	25	47	25	22
23	25	30	48	26	66
24	28	25	49	60	28
25	22	22	50	66	66

Table 73. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Story County—Isolate 2

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	28	22	26	60	30
2	25	28	27	26	25
3	22	66	28	28	45
4	26	26	29	25	35
5	28	25	30	30	28
6	25	25	31	65	28
7	30	66	32	25	22
8	35	28	33	45	66
9	22	26	34	30	45
10	28	22	35	22	23
11	66	45	36	28	30
12	26	66	37	22	45
13	25	28	38	25	60
14	22	30	39	26	28
15	45	45	40	66	26
16	22	22	41	28	45
17	30	26	42	25	66
18	28	22	43	35	22
19	45	35	44	22	30
20	66	28	45	28	45
21	25	66	46	28	28
22	28	35	47	25	25
23	30	22	48	35	35
24	45	60	49	22	45
25	22	26	50	66	22

Table 74. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Story County—Isolate 3

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	25	28	26	22	30
2	28	26	27	22	22
3	66	25	28	25	66
4	22	45	29	30	28
5	26	22	30	45	30
6	22	28	31	66	22
7	66	35	32	22	45
8	25	25	33	60	28
9	28	35	34	22	45
10	22	60	35	35	25
11	35	22	36	28	66
12	30	30	37	25	26
13	22	22	38	28	35
14	28	28	39	35	22
15	66	66	40	22	66
16	66	25	41	24	28
17	26	22	42	28	26
18	22	28	43	25	25
19	25	22	44	26	66
20	26	28	45	64	22
21	45	22	46	25	25
22	30	45	47	22	30
23	45	28	48	28	28
24	28	25	49	30	22
25	28	22	50	22	26

Table 75. Original conidial length measurements of isolates of C. persicariae from P. persicaria of Story County—Isolate 4

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	45	25	26	25	26
2	22	60	27	60	22
3	30	66	28	35	35
4	28	28	29	25	25
5	22	25	30	66	22
6	25	35	31	22	22
7	45	66	32	28	45
8	30	28	33	28	65
9	22	45	34	25	25
10	28	66	35	35	22
11	66	45	36	22	28
12	22	22	37	26	25
13	45	30	38	28	22
14	25	22	39	25	28
15	66	45	40	22	60
16	26	28	41	30	22
17	28	22	42	66	28
18	30	30	43	28	35
19	35	25	44	25	26
20	28	22	45	66	25
21	25	28	46	45	30
22	26	26	47	30	28
23	66	25	48	22	66
24	22	28	49	25	30
25	28	30	50	22	25

Table 76. Original conidial length measurements of isolates of *C. persicariae* from *P. persicaria* of Story County—Isolate 5

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	22	66	26	22	22
2	30	25	27	35	30
3	28	28	28	25	25
4	22	26	29	28	28
5	25	28	30	66	22
6	26	35	31	28	66
7	25	25	32	25	22
8	66	28	33	35	28
9	30	30	34	28	28
10	22	45	35	25	28
11	28	66	36	26	45
12	26	22	37	28	25
13	22	25	38	63	22
14	45	66	39	30	30
15	25	25	40	45	45
16	30	30	41	22	26
17	45	28	42	25	22
18	28	22	43	25	66
19	28	66	44	30	30
20	22	26	45	66	28
21	25	60	46	28	25
22	66	28	47	25	25
23	30	35	48	26	28
24	22	45	49	66	26
25	45	25	50	60	22

Table 77. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Story County—Isolate 1

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	36	23	26	22	66
2	25	66	27	25	22
3	66	25	28	28	45
4	22	45	29	70	70
5	25	22	30	66	28
6	70	35	31	26	26
7	45	25	32	28	28
8	26	22	33	25	25
9	28	25	34	70	28
10	66	28	35	30	25
11	45	26	36	26	30
12	22	45	37	66	70
13	30	70	38	45	45
14	28	28	39	28	28
15	26	25	40	22	26
16	70	26	41	26	35
17	25	70	42	45	22
18	22	66	43	25	66
19	28	28	44	35	70
20	35	46	45	22	30
21	45	26	46	66	25
22	30	28	47	28	70
23	28	22	48	70	26
24	25	25	49	25	30
25	26	35	50	28	28

Table 78. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Story County—Isolate 2

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	45	30	26	45	45
2	25	26	27	70	25
3	26	28	28	35	22
4	35	70	29	26	66
5	28	25	30	28	25
6	66	28	31	25	35
7	45	30	32	70	28
8	28	28	33	22	45
9	66	25	34	28	28
10	25	25	35	22	66
11	26	22	36	30	25
12	28	26	37	45	26
13	30	28	38	70	28
14	28	25	39	66	30
15	25	70	40	28	28
16	25	45	41	45	25
17	22	25	42	26	70
18	26	66	43	22	66
19	28	45	44	25	70
20	25	28	45	66	35
21	70	66	46	70	45
22	28	70	47	22	25
23	26	22	48	25	22
24	30	70	49	36	26
25	66	36	50	45	28

Table 79. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Story County—Isolate 3

No.	From host length	From *B. vulgaris* length	No.	From host Length	From *B. vulgaris* length
1	66	45	26	25	28
2	36	25	27	70	45
3	26	26	28	45	22
4	28	28	29	35	60
5	70	66	30	45	35
6	25	28	31	25	70
7	26	25	32	22	26
8	22	25	33	25	26
9	28	66	34	66	70
10	25	22	35	36	25
11	28	70	36	25	30
12	25	45	37	22	28
13	30	70	38	26	25
14	26	22	39	28	26
15	28	36	40	70	70
16	25	25	41	45	28
17	66	45	42	66	28
18	28	30	43	45	26
19	35	22	44	30	25
20	70	28	45	28	28
21	26	22	46	70	22
22	26	45	47	22	25
23	22	25	48	25	26
24	70	66	49	22	66
25	45	35	50	28	35

Table 80. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Story County—Isolate 4

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	45	45	26	70	28
2	36	35	27	25	30
3	25	25	28	70	22
4	22	28	29	45	70
5	25	26	30	45	26
6	26	70	31	26	25
7	45	45	32	22	36
8	30	25	33	35	26
9	25	66	34	28	28
10	28	28	35	66	70
11	45	26	36	25	28
12	70	25	37	22	30
13	66	45	38	26	28
14	70	26	39	25	22
15	22	23	40	25	70
16	30	26	41	28	30
17	25	28	42	26	25
18	28	22	43	70	36
19	26	25	44	35	45
20	28	70	45	26	70
21	30	22	46	70	28
22	22	30	47	22	45
23	28	45	48	28	26
24	28	45	49	30	70
25	45	22	50	45	25

Table 81. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Story County—Isolate 5

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	28	26	26	25	22
2	25	25	27	30	25
3	22	45	28	28	26
4	70	66	29	26	28
5	28	26	30	25	25
6	66	22	31	70	30
7	26	70	32	22	22
8	25	26	33	30	66
9	22	28	34	66	70
10	36	22	35	35	28
11	45	26	36	26	22
12	30	70	37	26	36
13	45	28	38	35	70
14	28	66	39	22	45
15	45	25	40	45	36
16	70	23	41	28	26
17	25	35	42	26	66
18	66	45	43	28	45
19	22	26	44	25	28
20	25	25	45	70	45
21	45	28	46	22	25
22	25	30	47	70	28
23	28	66	48	25	25
24	66	28	49	28	70
25	70	25	50	25	30

Table 82. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 1

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	22	70	26	36	36
2	70	45	27	45	26
3	25	28	28	28	25
4	35	66	29	28	22
5	22	70	30	22	45
6	36	22	31	70	70
7	22	32	32	35	22
8	45	30	33	45	22
9	40	45	34	66	45
10	25	22	35	32	28
11	26	26	36	26	66
12	26	26	37	25	40
13	26	25	38	32	45
14	22	25	39	70	36
15	36	70	40	25	28
16	70	25	41	66	45
17	66	28	42	70	28
18	22	70	43	45	70
19	45	32	44	35	36
20	28	26	45	22	22
21	36	66	46	28	70
22	26	35	47	45	45
23	45	45	48	36	66
24	22	22	49	45	28
25	70	22	50	66	22

Table 83. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Monona County—Isolate 2

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	25	28	26	22	22
2	26	22	27	35	70
3	22	70	28	36	45
4	45	35	29	70	66
5	28	45	30	45	70
6	66	70	31	22	36
7	22	28	32	40	26
8	30	22	33	25	25
9	32	32	34	26	40
10	70	26	35	36	22
11	25	25	36	70	45
12	25	25	37	66	70
13	28	25	38	45	36
14	26	26	39	36	28
15	32	22	40	28	36
16	22	45	41	45	45
17	28	70	42	22	28
18	66	32	43	26	45
19	45	30	44	66	36
20	35	22	45	36	22
21	70	66	46	45	36
22	23	28	47	28	66
23	28	45	48	22	28
24	70	35	49	28	70
25	25	25	50	45	45

Table 84. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 3

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	28	70	26	28	36
2	25	22	27	45	45
3	22	45	28	22	28
4	36	26	29	70	25
5	35	67	30	25	35
6	45	45	31	26	28
7	22	45	32	45	25
8	26	35	33	28	36
9	70	22	34	66	28
10	25	70	35	32	45
11	40	40	36	22	32
12	70	25	37	30	26
13	22	35	38	70	66
14	66	22	39	25	70
15	36	36	40	28	27
16	22	28	41	25	66
17	45	25	42	26	22
18	22	45	43	70	22
19	28	26	44	32	32
20	36	23	45	28	30
21	45	66	46	45	70
22	70	60	47	22	22
23	26	22	48	66	26
24	45	28	49	35	45
25	36	22	50	22	25

Table 85. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Monona County—Isolate 4

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	26	70	26	26	36
2	32	28	27	28	30
3	25	22	28	22	32
4	66	66	29	36	22
5	70	45	30	22	22
6	26	36	31	70	26
7	22	22	32	45	36
8	25	45	33	28	28
9	70	45	34	45	26
10	28	45	35	70	25
11	45	26	36	22	32
12	70	70	37	36	65
13	30	35	38	45	66
14	36	45	39	45	22
15	22	22	40	66	45
16	32	25	41	26	28
17	26	26	42	25	70
18	25	25	43	22	25
19	32	28	44	45	26
20	66	36	45	25	22
21	35	40	46	28	35
22	66	28	47	22	32
23	22	70	48	35	66
24	28	70	49	36	25
25	45	45	50	40	26

Table 86. Original conidial length measurements of isolates of *C. polygonorum* from *P. pennsylvanicum* of Monona County—Isolate 5

No.	From host length	From *B. vulgaris* length	No.	From host length	From *B. vulgaris* length
1	45	35	26	45	22
2	28	22	27	28	28
3	22	28	28	32	22
4	66	22	29	25	28
5	26	70	30	70	25
6	45	36	31	32	32
7	66	22	32	22	28
8	70	70	33	28	25
9	40	36	34	28	70
10	45	45	35	35	70
11	25	25	36	36	26
12	22	22	37	22	65
13	35	36	38	70	45
14	22	45	39	25	25
15	45	25	40	28	46
16	65	70	41	70	40
17	26	28	42	36	26
18	28	23	43	22	65
19	25	30	44	36	22
20	30	25	45	28	45
21	66	28	46	22	28
22	70	36	47	45	45
23	26	28	48	36	70
24	25	32	49	28	66
25	23	36	50	36	22

Table 87. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 6

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	45	28	26	25	25
2	28	70	27	45	23
3	66	32	28	26	28
4	26	22	29	32	45
5	70	29	30	70	29
6	22	35	31	35	32
7	45	28	32	22	26
8	66	45	33	28	70
9	40	26	34	36	28
10	22	66	35	26	70
11	45	28	36	36	45
12	25	22	37	45	26
13	70	37	38	28	45
14	35	45	39	32	23
15	22	22	40	28	26
16	66	70	41	25	45
17	70	25	42	70	22
18	28	36	43	22	70
19	45	66	44	36	66
20	25	26	45	28	25
21	30	70	46	22	22
22	22	40	47	36	26
23	26	22	48	23	36
24	66	36	49	45	30
25	26	35	50	29	22

Table 88. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 7

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	36	35	26	28	25
2	22	25	27	36	36
3	45	45	28	22	28
4	28	26	29	26	32
5	66	22	30	70	22
6	26	68	31	35	28
7	38	70	32	45	30
8	25	28	33	25	25
9	68	22	34	70	36
10	45	46	35	22	26
11	70	45	36	35	70
12	28	28	37	22	25
13	25	22	38	25	23
14	22	26	39	45	36
15	28	45	40	26	26
16	45	66	41	22	45
17	70	28	42	32	70
18	36	22	43	28	28
19	28	70	44	70	22
20	45	32	45	22	35
21	28	36	46	32	66
22	66	45	47	70	22
23	45	70	48	30	45
24	22	28	49	26	66
25	45	45	50	25	25

Table 89. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 8

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	28	22	26	28	66
2	45	25	27	30	30
3	22	36	28	25	28
4	45	35	29	22	70
5	70	22	30	28	36
6	22	36	31	25	32
7	26	23	32	45	45
8	25	28	33	28	28
9	22	22	34	66	66
10	45	35	35	35	22
11	66	26	36	40	25
12	70	28	37	25	46
13	36	66	38	22	70
14	26	22	39	32	66
15	22	70	40	35	26
16	45	25	41	70	26
17	26	32	42	45	22
18	32	40	43	36	26
19	66	45	44	35	45
20	26	35	45	22	28
21	45	28	46	36	70
22	22	70	47	66	22
23	70	25	48	23	45
24	66	45	49	28	46
25	28	22	50	26	25

Table 90. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 9

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	25	25	26	22	23
2	26	28	27	66	36
3	22	46	28	45	30
4	45	25	29	70	22
5	25	22	30	28	66
6	26	45	31	22	45
7	25	38	32	25	70
8	36	70	33	46	22
9	22	25	34	22	32
10	28	26	35	70	66
11	36	22	36	26	46
12	46	22	37	40	70
13	66	70	38	28	66
14	70	25	39	36	22
15	36	45	40	28	46
16	22	25	41	66	26
17	28	36	42	22	28
18	70	28	43	70	36
19	28	22	44	45	26
20	45	65	45	32	22
21	38	35	46	36	45
22	25	26	47	66	28
23	22	70	48	32	28
24	45	36	49	30	32
25	26	28	50	66	40

Table 91. Original conidial length measurements of isolates of C. polygonorum from P. pennsylvanicum of Monona County—Isolate 10

No.	From host length	From B. vulgaris length	No.	From host length	From B. vulgaris length
1	26	28	26	22	29
2	22	65	27	28	70
3	46	40	28	66	25
4	36	46	29	45	23
5	45	70	30	22	66
6	22	35	31	40	25
7	32	28	32	28	26
8	26	26	33	45	28
9	66	35	34	66	36
10	25	22	35	26	22
11	36	46	36	66	70
12	25	28	37	70	32
13	36	25	38	30	45
14	70	70	39	22	25
15	22	22	40	25	28
16	26	26	41	28	36
17	46	28	42	36	70
18	28	36	43	32	46
19	66	66	44	45	22
20	36	30	45	70	27
21	28	22	46	23	45
22	22	45	47	25	22
23	28	25	48	25	28
24	70	22	49	28	35
25	29	66	50	35	32